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The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it.

EDITORIAL

LEGISLATION, POLITICS, AND EDUCATION

OF THE making of laws, as of books, there is no end. With the advent of winter the thoughts of the average American turn naturally from football to legislation. With Congress already in session and most of the state legislatures about to convene, the stage is set for all those so inclined to indulge in the exciting indoor sport of curing the country's economic and moral ills by legal fiat.

Last spring friends of forestry were successful in obtaining the passage of two measures of outstanding national importance—the McNary-Woodruff Act and the McSweeney-McNary Act. At the present short session of Congress interest centers on the appropriation of amounts adequate to make these and other laws already on the statute books really effective rather than on the passage of new legislation. So far Congress has been more liberal in authorizing a progressive forestry program for the nation than in providing funds to carry it out. Foresters may disagree as to the advisability and constitutionality of additional federal legislation enforcing the practice of forestry by private owners; but there can be no difference of opinion as to the importance of the steps so far taken, or as to the urgent need of funds to put the program already adopted on paper into practice in the woods.

Most of the states have not yet gone so far as the government in the formulation of comprehensive forest policies. Consequently the situation there calls for new legislation as well as for bigger appropriations. This fact and the steadily increasing interest in forestry and other phases of conservation make it certain that the coming winter will see the legislative hoppers filled with an even larger grist than usual of bills designed to solve our forest problems. Many of these will deserve favorable consideration; for, much as one may deplore the general tendency to legislate without limit on every conceivable subject, there is no doubt so far as forestry is concerned of the need of legal action not only to remove existing obstacles to tree-growing but to contribute to its progress in a constructive way. However desirable a *laissez faire* attitude may be in some fields, the public interest in forest perpetuation is too keen and too direct to let nature take its course unguided.

This being the case, it is to be hoped that local sections and individual members of the Society of American Foresters will take an active leadership in initiating and supporting desirable legislation. Let no one be deterred from doing so by the cry that this is "playing politics." Webster's first definition of politics is "the science and art of government." Surely no good citizen, and more particularly no good forester, should hesitate to play

his part in that game. What better opportunity is there for the Society, its Sections, and its individual members to give concrete evidence of their devotion to public service than by active participation in bringing about better government in the field with which they are most familiar?

This need not involve entanglement in the machinations of partisan politicians and self-seeking lobbyists. It should involve the straightforward, clear-cut presentation of the essential facts in the situation, with constructive recommendations as to the action desirable in view of those facts. The foresters of the country are obviously better qualified by training and experience than any other group to advise on matters connected with their own profession. To decline to do so would be to evade a definite responsibility and to ignore an exceptional opportunity for service of a high order.

On the other hand, let no one delude himself with the comfortable belief that our forest ills can be magically cured by a few passes of the legislative wand. Legislation is only a means to an end, and not an infallible means at that. The effectiveness of laws is measured not by the cleverness of their construction, or even by the highness of their ideals, but rather by the public support and technical knowledge back of them. Drastic fire laws will not accomplish much if the public does not want them enforced; ample provision for state forests will be of little value if the state forestry department is not so organized and manned as to handle them effectively.

Foresters need to remember that the successful practice of their profession demands not only the sympathetic cooperation of the general public, based on an intelligent appreciation of the public benefits of forestry, but also a knowledge of its fundamental principles and methods on the part of forest owners. With all the preaching that foresters have done, it is doubtful whether the average citizen even yet has more than a dim realization of what forestry means to him and his children; or whether the average timber land owner has more than a vague conception of the meaning and implications of sustained yield. How many, even among the leaders of the lumber industry, think of timber growing except as a process which involves the clearing off of the original forest, planting, and the accumulation of compound interest and other carrying charges for several decades until the new crop is ready to harvest? To how many of them is "normal growing stock" more than a meaningless phrase? Is there a single tax assessor who understands the elements of forest valuation? Yet how can we expect to make progress in tax reform, or in better forest management, or even in the enforcement of mandatory measures until there is a more widespread appreciation of such fundamental principles as these?

Let us have all the legislation necessary for the establishment and execution of sound forest policies; and let foresters by all means participate actively in securing its enactment. But in so doing let us not neglect the equally essential task of educating public and timber land owner to a clearer conception of what forestry means and is. This is an activity in which every forester can do his share, no matter how restricted his sphere. Its importance cannot be overemphasized.

TREE "SEED FARMS"

By CARLOS G. BATES

Senior Silviculturist, Lake States Forest Experiment Station

IN THE JOURNAL OF FORESTRY for February, 1927, the writer described some of the dangers to forestry and to future forests arising from the existing methods of collecting large seed supplies without regard for either the individual qualities of the mother trees or the suitability of the strain to the climatic conditions under which the seedlings are eventually planted. Since that writing there has been a rapid development of interest in the problems of heredity as they bear upon forestry, reflected not only in numerous articles and translations, but also in new research projects and, still more important, the introduction, by more than one American seed dealer, of "certified seed." Heretofore it has been practically impossible in ordering tree seed from the larger dealers to learn anything definite as to the origin of the seed, and there is still a long distance to go before the situation will be satisfactory, if only because the available natural supplies are so far from being uniformly good. While geographic origin is important, more attention should also be paid to the character of the trees from which seeds are taken.

Much discussion will doubtless be indulged in before American foresters will become convinced of the importance of good seed as the foundation of reforestation work. "Needed research" will be used as an excuse for postponing definite provision for seed supplies. It is true that many points of an academic nature need to be investigated before we shall know the full story as to what tree characters are of an hereditary nature and as to how they are transmitted. Such problems as the range of dissemination of pollen need study before we can be certain of full success in any of the more practical breeding experiments. These and many other minor points may occupy aspiring Doctors of Philosophy for several decades to come.

Nevertheless, it is possible to point the way to certain practical steps for seed improvement which can be taken at once. It is believed that such direct methods of dealing with the problem will carry a greater appeal to Americans than suggestions for legislative or regulatory treatment, despite the tendency toward lawmaking for every conceivable purpose. Without doubt some organization of seed users and seed producers is necessary to effect a cessation of present bad practices and the most economical use of such good seed as is available. The final step of providing for the future may prove to be entirely a governmental function, although we can see in it opportunity for private enterprise and profit.

WHAT IS A "SEED FARM"?

The conception of "farms" for growing forest tree seeds of desirable quality may be readily understood by any one who has seen the farms maintained by the better purveyors of garden and field seeds for the production of seeds of pure and special strains. These dealers do not depend on the ordinary farmer for their

supplies, although they may draw new materials from especially good fields of individual farmers, or where the farmer's stock is pedigreed or has the requisite history for certification. The term "certification," however has different meanings in different connections: in the case of seed potatoes it may mean little more than freedom from potato scab and practically nothing as to the previous history of the strain from which the current crop has been grown.

As used in this discussion a "seed farm" for the production of forest tree seeds may mean any planted or natural tract of timber dedicated to the production of seeds of desirable quality and prepared therefor by artificial selection methods, with or without supplementary natural selection. The idea of planting trees of known origin and superior quality for the primary purpose of seed production is, we believe, essentially new, and is the natural outgrowth of experimental work which has been under way for some time, having in view the determination by trial of the best sources of seed for reforestation work in any particular locality. On the other hand, the setting aside of tracts of especially desirable timber, to be dedicated primarily or solely to the supplying of seeds, has reached considerable proportions in some European countries and is the outgrowth of regulatory measures which are in effect to bar certain undesirable seed supplies from use and to limit the movement of others to certain restricted climatic zones. In short, experience, supplemented by experiments which have been under way as much as 25 years in some instances, has taught that the seed from certain localities has superior value for reforestation under certain conditions, and steps have been taken to insure the supplies for future needs, but so far as we are able to determine the artificial improvement of the seed stands has not been undertaken.

"Good seed" as used in this discussion means tree seed from parents which have stood the test of time in proof of their adaptation to the conditions under which they have grown and under which their progeny will be grown. This adaptation implies resistance to diseases and insects as well as suitability for climate and soil, all of which are so closely interrelated that the influence of one and all is expressed at least partially in the form and vigor of the tree. Good seed may, therefore, be obtainable as the result of either natural or intelligent artificial selection. The conception of seed farms may, likewise, be made to include both virgin mature stands in which the process of natural selection has had full sway, and young natural or planted stands which have been thinned with careful consideration of the qualities of each tree. While the treatment of young planted stands, because of the uniform spacing of the trees, offers the best opportunity to judge the relative vigor of individuals, it must be realized that such a character as clearness cannot even be prognosticated at an early age, while the adaptation of the individual to unusual climatic factors, disease, and insects cannot be fully judged until the tree has been subjected to all possible dangers, and is mature or nearly so. The young natural stand, always showing wide variations in the spacing of its trees, offers fewer advantages for development of a seed "farm" than either the old or the planted stand, being neither "tested through fire" nor susceptible to accurate biometric treatment.

Use of Mature Stands for Seed Collecting

In dealing with the natural seeding from virgin mature forests, or their use for seed production under systematic development, we are favored by the fact that, as a general rule, only the superior trees of even-aged stands reach that dominant position in the canopy which permits them to be seed-bearers in a large way. Intermediate and suppressed trees, while possibly contributing pollen, are rarely able to mature their seeds and therefore are only half as important. While the dominant position in the stand may, it is true, be attained occasionally through accident, nevertheless we believe that a process of natural selection for fitness goes on during the life of any stand, and it is this process which we should turn to good use in our seed collecting.

To illustrate the possibilities of development of a remnant virgin stand for seed production, and its importance in forest planting on a large scale, a concrete example may be given, although this development has not as yet passed the "paper" stage. In northwestern Wisconsin there is a large area (several townships) of potential Norway pine land known as "The Barrens," a portion of which is under consideration for purchase as a National Forest unit. This is rolling sandy land, so completely devastated that its present "forest" consists only of small patches of jack pine and of scattered small seedlings of jack and Norway pine. There is ample evidence that there is no natural barrier to its reforestation except lack of seed, and probably no one would controvert the idea that planting is called for and justified since the natural seeding-in of the entire area will require several decades at least.

Let us say to make the example more concrete that the federal government decides to reforest 100,000 acres of this barren land with Norway pine at the rate of 4000 acres per year and 1000 trees per acre, or a total of 4,000,000 seedlings per year. A generous estimate will allow the production of 40,000 seedlings from a pound of Norway pine seed; there will, therefore, be required for this operation at least 100 pounds of seed per year. Considering that Norway pine produces good crops only about once every five years, at least 500 pounds of seed must be collected whenever there is crop enough to justify collecting at all. Whence shall such a supply of good seed come? Valuing the seed at the minimum cost of collection, about $5 per pound (the market price often reaches two or three times this figure), the outlay is not great from the standpoint of its contribution to the planting cost, yet the production of this crop might mean a tidy bit of income to any forest owner.

There is sufficient Norway pine within the general locality to furnish this seed, without crossing any climatic barriers or going beyond the boundaries of the sandy soil type. Most of this, however, is in the form of small tracts of "second growth" which do not promise much either as to the quality of the trees or as to volume of seed production. On the other hand, an extremely fortunate possibility exists of collecting seed from a tract of about 100 acres of virgin Norway pine on a private estate which has escaped both the axe and the fires which have swept the country since its cutting. This timber consists almost entirely of

veterans more than 200 years old which have undoubtedly passed their prime in both growth and seed production. Despite this age, it is believed that this single area can be expected to produce the quantity of seed computed above, provided only that the owner will permit some cultural improvement of the stand. This would consist of the removal of an occasional tree which shows strong susceptibility to heart rot, or whose stem is of undesirable form, or which has been below normal for the species in its natural pruning. Such a supplementing of nature's long-drawn elimination process would in a younger stand almost certaintly result in a slight increase in the growth and seed-producing capacity of the remaining trees, and even with these veterans it is believed will have those effects in some slight degree. In any event, whatever seeds may be obtained after this proposed cleaning of the stand will approach the ideal of "good seeds" for this particular reforestation project as closely as it is possible to go.

The owner of this tract of 100 acres of Norway pine, if commercially minded, would be entitled to a royalty of at least 50 cents on every bushel of cones, for which collectors in Wisconsin receive from $1 to $4 per bushel at delivery points. Assuming that it is capable of producing every 5 years the 500 pounds of seed desired of it, or the equivalent, about 700 bushels of cones, this would amount to 70 cents per acre per annum, which is certainly not a bad return from land which can not command $2 per acre in the present-day market. Just how long one might be justified in retaining merchantable timber for this revenue we shall leave for an economist to compute. Needless to say, the collection of the cones from these mature trees might depend upon the activities of squirrels, although in this instance it would seem possible to employ a portable tower to reach the tree tops.

It is gratifying to learn that the state of Pennsylvania through State Forester Illick is already setting aside for seed-producing purposes primarily some of the more desirable of its few remaining tracts of Norway pine. This is only a last resort in the case of a species which is near enough extinction seriously to hamper projected reforestation work. In the less critical cases, such as those of the southern and western pines, it should still be possible to set aside not only tracts, but the very best tracts of virgin timber, properly distributed throughout the range of each species, and so to clean these stands that they may be depended upon to yield seeds practically free from any weakness or taint whatever. Given an area of appreciable size in the midst of a larger area of similar natural quality, the probability of pollination from undesirable trees outside the treated zone may be discounted to almost nothing.

Growing Young Forests for Seed

The plan of utilizing young planted forests for the production of seeds of desirable quality is a natural outgrowth of the consideration of the superior values of mature virgin trees. If mature stands are becoming not only rare but decadent, and if at best it is a difficult matter to collect the seed from the tallest and finest of forest specimens, why should we not cultivate for seed production plantations of the *progeny* of these fine specimens? The progeny will pos-

sess the same inherent characters (and it is only with the inherent characters that we are concerned), among them we can make still further selections, and they may, by proper cultural methods, be brought to seed bearing at a comparatively early age, while their seed may be collected without undue effort.

The first steps along this line have been taken in connection with experimental plantations designed to bring out the difference between theoretically desirable and undesirable forms, strains, or varieties of a given species. In its simplest form we may consider such an experiment as including every available seed source of a given species. Seeds are collected from the latitudinal extremes of the range of the species as well as from many intermediate points. As far as possible collections are made from individual trees or small groups exhibiting characteristics of bole form and growth vigor, clearness, forking, disease resistance, etc., which can be measured or described. These climatic and individual forms are then brought together for growing at one or several places within the natural range of the species. Using the utmost care to provide uniform conditions for all of the lots of seedlings in the nursery as well as in the field, both climatic adaptation to the new site and individual characters of the parents which are heritable should be brought out at a comparatively early age. The result is that, after a period of perhaps twenty years, we may have a collection of young trees of very varied origin, of which a certain proportion will show themselves adapted to the new growing conditions. For the determination of general principles we are intensely interested in the *origin* of those which are, and of those which are not, adapted, so that in the future we may know just where to go to supply a certain local requirement for seed, and from what types of trees we may safely take the seed. On the other hand, for the next step, which represents the practical "breeding" accomplishment, we are concerned only with the fact that we have this assortment of desirable trees of varied origins, or at least not all of the *same* origin. The undesirable individuals, whatever their origin, may at this stage be weeded out. Those remaining may be developed rapidly by the thinning toward the full-crowned form which is desirable for seed production. It will, however, be desirable, even after the original weeding, to maintain even spacing as closely as possible, so that the inherent vigor of the trees stands out clearly, unaffected by any individual advantages of position. A more or less continuous process of selection seems desirable even after seed production has begun, especially as the seed-producing capacity of individuals varies as greatly as any other character, and non-producers should be eliminated if others will be benefited thereby.

Whether or not this plan of procedure is as directly productive of the desired results as one which involves only the collection, at the outset, of seeds from very superior and well-tried parents, remains to be seen. The point, of course, is that the former plan contains a wider range of experimental and scientific possibilities. In addition, it seems probable that the bringing together or unrelated "blood lines" from widely separated sources may introduce into the progeny new vigor, just as the first crossing of separate species produces usually a hybrid of greater vigor than either parent.

On the other hand, if only seed from the immediate locality of the planting site were employed in any instance, and these were all from choice specimens whose pollination was likewise of desirable origin, the chances of obtaining a high percentage of "desirables" in the plantation would obviously be better, and there would be less chance of any undesirable characters appearing in the progeny late in life.

A concrete example of "seed farming" may be given in the efforts to overcome the planting difficulties of the Nebraska National Forest, which have apparently arisen in no small measure from the use of stock of undesirable origin. Native western yellow pine in Nebraska is very widely scattered, making it difficult to collect seed from it. Since it is, moreover, of short stature, the early opinion was that the better classes of pine to be found in the Black Hills and at various points in the Rocky Mountains comprised more desirable seed sources. It was not until seed from these distant origins and radically different climatic conditions had been used for nearly twenty years, that it began to be suspected that both the insect injury and the *Peridermium* which were prevalent in the plantations might be fostered by lack of inherent resistance in the trees and their comparatively poor adaptation to the site and climate. At about this same time seedlings from local seed were making an outstanding showing in the nursery, and it was also possible to trace some of the oldest and cleanest of the plantations to a lot of seed which had been collected in Nebraska at the very beginning of the undertaking. An outstanding case of tip-moth injury was, at the same time, traced to seed of New Mexico origin, while, apparently, the Black Hills seed which had been used more largely than any other, produced trees of a fair degree of adaptation.

These observations led to a desire not only to compare local seed with that of other origins in plantations under identical conditions, and thereby to prove to administrative officers the justification of a greater expense for seed collecting, but also to lay the foundations for a future seed supply by bringing together seedlings from the best possible specimens of the local pine. To this end a number of seed-bearing trees of unusual vigor were selected over a wide territory and the work of collecting their seed, as available, and of growing and planting out the stock derived therefrom, is being prosecuted by Supervisor Higgins of the Nebraska Forest and by J. Roeser of the Rocky Mountain Forest Experiment Station. It is planned that all such stock which becomes available for a number of years shall be set out in a segregated area in order that it may always be free from pollination from undesirable sources; that as the trees develop undesirable individuals shall be weeded out, susceptibility to rust and tip-moth injury, as well as general vigor, being given consideration in this process, since it was plainly apparent in the selection of the mother trees that specific immunity to the gall rust is possible; and finally, that seeds of other origins shall be tested in the same manner for their relative merits, and shall be eliminated from this plantation only as they show obvious inferiority. From this plantation there will undoubtedly come, in the course of years, a sufficient supply of "pedigreed" seed to carry most of the planting project. Such a supply is especially important in

this case not only because of the peculiarity of the planting site relative to other yellow pine types, but also because the planting of the Forest is likely to proceed over a very long period before it is completed, with some chance that the second regeneration may also have to be by means of planting. Unfortunately, trees of desirable character, already established and close to seed-bearing age, cannot be used as seed producers with complete confidence because they are not sufficiently segregated from undesirable specimens. However, where the former occur in sufficient numbers to warrant, even the cleaning of the general plantations may be resorted to when there is a little more confidence in the principle involved.

There is now afoot a similar move to test the climatic and individual forms of Norway pine in the Lake States and other portions of its range, and to develop from such tests seed farms of this species independent of any that may yet be recovered from among the fast-disappearing virgin stands. In this instance it is probable that as many collections as are available will be tested, for scientific purposes, in the north, south, and middle portions of the Norway pine range, without reference to any particular reforestation project or needs, and that the small test plantations will gradually be extended to sizes suited to practical seed production, after the first experimental results have been observed and suitable material comes to hand. In carrying out such a dual purpose project there are certain important safeguards to be considered, which may be enumerated here:

1. The site selected should be segregated from existing stands of the same species as far as possible. It is believed that one-half mile is sufficient distance unless the natural stands are extensive enough to produce a large volume of pollen, when a much greater distance would be desirable.

2. Since time is an important element in the project, the site should be carefully chosen for the most vigorous growth of a given species, but the mixing of species in such plantations will have serious disadvantages, especially if they do not have the same growth rate. The use of a single area for seed farms of more than one species is not objectionable if the soil conditions are suitable.

3. The site should be an even plain or slope with the greatest possible uniformity of soil conditions.

4. The conditions of competition at the outset should be made as uniform as possible through cultural means, and should be maintained so until the trees are competing largely with one another. The trees should be evenly spaced.

5. Any given lot or variety entering into the test should be planted in a number of places, and in each case in proximity to different neighbors, so that the individual lot meets all possible variations in competition. The unit tentatively adopted for such division is one of ten trees, but regardless of this, the lot should appear in at least ten places in the plantation.

6. Since certain poorly adapted lots are likely to disappear entirely from the plantations, study should be given at the outset to the probable chances of each lot, and in order to avoid large openings in the stands, undesirable or possibly weak lots should be evenly scattered among the better ones.

7. Immediate losses after planting should be replaced in order that even competition may be maintained through-

out the plantation until the trees are large enough to be judged on their merits.

8. It is probable that under the conditions prevailing in the Lake States weeding of the plantation may be begun at the end of ten years, and that small seed crops may be expected by the time the trees are twenty years old. Both stages can probably be hastened by the wise use of fertilizers, which should, however, be used cautiously to avoid inducing growth phenomena which may materially affect the hardiness of the different varieties, such as too prolonged growth in the late summer.

Such plans as those described above for the growing of stands to produce good seed may seem rather remote. While they are developing, there are certain obvious things that can be done to diminish the dangers of the present hit-or-miss use of seeds. The best existing mature stands of any species can be utilized, as has been described for mature "seed farms." Haphazard seed collecting which may, and often does, include the least desirable trees, can be discouraged by the demands of seed users for some knowledge of the kinds of trees from which seed has been taken. Still simpler is it for the seed user to insist that the seed supplied him shall be from the same climatic zone as that in which it is to be used. There is no need to attempt to set up arbitrary zones; probably summer temperatures define the important differences of climate as nearly as any one element, and it is not difficult for any one to ascertain whether the point of collection varies from the planting site in summer temperatures by an amount sufficient to involve the risk of poorly adapted stock.

Perhaps it is most important of al that both public and commercial nurseries should keep a record of the seec sources of all their stock, and be able tc allocate each lot back to its origin wher the opportunity exists, instead of sending it where it is least likely to give gooc results. For example, Norway pine ir the Lake States grows naturally in a climatic belt about nine degrees "wide" as measured by summer temperatures Any movement of seed or stock to a region more than two degrees colder or warmer than that in which the seed wa grown would seem to be unnecessary since any third of the entire belt i capable of producing all the seed tha may be needed locally.

Out of these considerations grows a need for a much greater exchange of information on available seed supplies an their quality. In each forest region a central clearing house for such information seems a prerequisite of intelligen action. Whether such activities wil point to continued bad practices whic require "regulation" remains to b seen. We expect to have more to sa on this subject at a later date.

SOME ASPECTS OF FOREST GENETICS

By PERKINS COVILLE

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General

THE human race has been improving plants and animals for its own betterment for thousands of years. Most of this improvement has been brought about, until recent years, by the crudest of empirical means. The science of genetics is extremely young, and though it has made revolutionary changes in our knowledge of breeding plants and animals for some definite characteristic, it does not even yet enable us to simplify all breeding problems. Time is still a very serious factor in tree breeding. The man who is interested in the breeding of trees may well envy the man who is breeding annual crops, with their annual generations, for generations in forest trees may often be as long as generations of the human race, and several generations may pass before many of the desired results are obtained.

Even a casual study of breeding forest trees for rapid growth, with a correlated study of the general subject of genetics, makes one feel that the breeding of everything but forest trees has been attempted. The development of new species or varieties of trees has generally been for the purpose of producing a better fruit, not to produce a larger quantity of better quality of wood. Even the cultural methods used for improving the growth rate of trees in a forest stand or for securing reproduction have been little, if at all, based upon an understanding of the hereditary characters of the trees dealt with. Foresters do not know enough about heredity in trees to place their silviculture upon a sound basis, for, surely, doubt as to the quality of our seed and seedlings means doubt as to the quality of the resulting timber. This is evidenced by many recent publications (1, 16, 19, 24, 27, 29, 38).

Silviculture and Genetics

Silviculture is generally considered to be the fundamental forest science, but it is based in turn upon such sciences as chemistry, physics, plant physiology, and soils. In all of these applied sciences there are serious gaps in our chain of knowledge. For example, the chemists are vague about the chemical composition of wood. The physical forces activating water in plant tissues are only slightly understood. Such an apparently elementary phenomenon as the germination of a seed cannot be completely and concisely explained. The recent endowment of a chair of forest soils at a prominent university was accompanied by a public statement of the great need for furtherance of this phase of scientific knowledge.

Silviculture, then, is greatly handicapped, not only by a lack of much general scientific knowledge, but also by the absence even of collected and correlated information of the "practical" sort which has already been gleaned bit by bit. Silviculture still is inadequately covered in our literature. It appears that we must, of necessity, because of the in-

tricacy of the subject and our lack of knowledge, be very vague, wrong, or quite speechless when asked for an answer to many of our silvicultural problems.

Silviculture attempts to keep forest areas at their maximum productive capacity. Yet productive capacity at the present time is limited by the incompleteness of our knowledge, by economic circumstances, and by the quality of the species on certain areas. At the same time we can see more and more clearly the probability of a timber shortage in the near future. One must, then, admit that the development of fast growing forest trees appears to be a matter of considerable economic importance, a means of increasing productive capacity, perhaps, *more rapidly* than any other means.

Genetic Principles and Tree Breeding

If one studies the subject of genetics he usually finds lucid diagrams and descriptive matter explaining the ratios in which the dominant, recessive, or mixed characteristics of the parents are transmitted to the offspring. These Mendelian principles are usually illustrated by means of several generations of rats, guinea-pigs, or Drosophila flies; some times by plants. The ratios in many of the elementary cases are so mathematically uniform that one is likely to get the idea that all breeding difficulties but the pure labor of control and compilation are done away with. For example: To go back to elementary genetics, Mendel found that crossing a parent with a pure dominant character (D) and one with a pure recessive character (R) produced offspring according to the formula: 1 D: 2 DR: 1 R, *i. e.,* 1 part (D) pure dominant, 2 parts (DR) mixed with only the dominant character in evidence, and one part (R) pure recessive, with only the recessive character showing. This means that 3 parts give evidence of the dominant characteristics. It is interesting to note, apropos of the uniformity of the ratios, that seven experiments with peas, each one for the purpose of testing inheritance of a different character, gave actual ratios of 2.96 to 1, 3.01 to 1, 3.15 to 1, 2.95 to 1, 2.82 to 1, 3.14 to 1, and 2.84 to 1. The average of the seven experiments was 2.98 to 1. (5).

Difficulties attend the application of genetics to the breeding of trees. Many trees, because of centuries of cross fertilization (cross breeding) the heterozygous for many factors, equivalent to the part represented by 2 DR, above. If we wish to produce trees in which rapid growth is the dominant characteristic, the recessive character or factor of poor growth should not only be bred out and eliminated as nearly as possible, but the dominant, rapid growing tree we hope to develop should, in turn, bear only seed that will produce a like tree. This means that it should not be allowed to cross with another tree with recessive or mixed characters. It is almost impossible to accomplish this unless we grow the trees in isolated plots, as pedigreed Rosen rye is grown, on an island in Lake Michigan, isolated from other ryes; surround them by species with which they will not breed; or, for further breeding purposes, make all pollinations by hand.

Of course, if we are to plant an area at the beginning of each rotation, and never expect to use *in situ* the seed from the forest stand of rapid growing trees we have produced, it is possible to keep relatively small isolated stands of the

pure strain to be used as a source of seed only. It would not be necessary then to see that our main stand was kept free from crossing with other species or varieties. The idea of a seed source of good quality is being carried out in Pennsylvania (26) where stands of good quality Scotch, red, and white pines have been chosen as sources of good seed. These stands might be said to be chosen by selection for no breeding as such has entered into their evolution. It has merely been noted that they are better stands than the average and as such should be sources of better than average seed, to be used for new stands. Also they are not *isolated* stands.

Forest trees may be said to be of great value only in the aggregate, not as individuals. The quality of rapid growth which is found in many individuals could be reproduced by grafting, but the expense of grafting a cion of such stock to a root stock of an ordinary seedling of like species is not justified at the present time. Grafted stock would also be likely to cross breed, and if it happened to be heterozygous, as is probable, or to be a mutation, it would not give us suitable seed upon reaching maturity or seed-bearing age. And again, if grafted stock is used to establish a stand we would be forced to start a new generation artificially at the end of the rotation or the area would be regenerated with reverted stock of ordinary or poor growth.

Genetics and Horticulture

If one turns to horticulture for encouragement in tree breeding he is likely to be disappointed, but it must be remembered that most past improvements were brought about by a crude form of selection, that pratically all of the good varieties were propagated by grafting, and that horticulturists, like the rest of us, have not had the guidance of any precise knowledge of genetics until recent years. The development of new tree fruits usually takes much longer than that of annual crops and in that respect it is similar to our own problem. Improvement of horticultural crops has received much more attention than the improvement of forest trees mainly because the food value of the crop produced by horticultural stocks is so important. Apples have been tremendously improved, but a long time has also elapsed since Pliny wrote (5) that some varieties were so sour that they took the edge off a knife. Fruit trees were often grown near dwellings, where they were easily observed and where any especially good qualities or unusual characteristics could easily be taken advantage of. Also the laws of chance have entered into the development of many forms. One man sowed over a bushel of apple seeds and one seed produced the Wealthy apple (5). Likewise, one million seedlings of soft maple were grown out of which one popular form of cut-leaf maple was picked.

Even today there are few "pure" horticultural plants. Most good species or varieties are propagated from cuttings. Although the first generation crosses of fruit trees will seldom produce the desired qualities, double crossing, self fertilizing the cross, or back crossing with one or the other parent, followed by selection, should produce some good individuals. Even here the time element has caused most operators to confine themselves to first generation crosses in the hope that chance would produce a

good seedling. If these first generation trees prove undesirable, they are usually destroyed, although genetics indicates that they have potential value as possible parents for another generation, some of which might prove to have very desirable qualities.

A perusal of Rehder's "Enumeration of Coinfers" (4) impreses one with the large number of evergreen species under cultivation. Horticulturists have developed a surprising number of recognized varieties from many of these, but there is apparently quite a lack of authentic hybrids. This is a little dampening to a neophytic tree breeder's ardor when he realizes how much artificial manipulation these evergreens must have been subjected to in the quest for new forms and varieties.

The statement of Bailey (5) that "Among American fruit plants there are comparatively few valuable species-hybrids" would seem to indicate that there would be little success attending species crosses in forest trees. This statement is based primarily upon the ability of the fruiting plant to produce large quantities of good quality fruit, whereas the forester is striving for more rapid production of wood. It may ignore the factor of hybrid vigor.

Hybrid Vigor

Hybrid vigor is a term applied to the vigorous qualities exhibited by some of the offspring of hybridization. One of the vigorous qualities is that of increased growth rate. Hybridization, then, would seem to be one of the good ways of obtaining more rapid growing trees.

Bailey (5) states that the honor of producing the first plant hybrid artificially is attributed to J. G. Gmelin, who accomplished this near the end of the seventeenth century. Thomas Fairchild crossed Sweet William and Carnation about 1710-1720. Linnaeus produced several hybrids. Kolreuter (1732-1806) laid the foundation of scientific knowledge. Thomas Knight worked with numerous vegetables and fruits. C. F. Görtner did some excellent work from 1825-1850. Apparently (3, 21) the first recorded tree hybridization was carried on by Klotzsch at Berlin, in 1845, when he crossed two species each of pine, oak, elm, and alder. He noted the augmented rapidity of growth and the increased durability of the new hybrids, but the work was not continued. In fact such work has only recently received much attention.

Not all, and in some cases not even a major proportion, of the generation resulting from hybridization are necessarily markedly superior to the better parent in some quality. For example, Richey (37) states, relative to the results of extensive hybridization of standard varieties of corn to improve yields, that, "of the 244 crosses, 201 yielded more than the average of the parents and 43 yielded less than this average. This is striking evidence of the tendency of hybrid vigor to increase yields. Of the 244 crosses referred to, 86 (about one-third) yielded over 5 per cent more than the better parent." On the other hand Houser (25) working with first generation tobacco hybrids found that his hybrid yields exceeded, in all cases, not only the average of both parents, but the better parent as well. The lowest increase in yield was 7½ per cent, the highest 31 per cent, and the average 17½ per cent.

There has been a great deal of experimentation with such crops as tea, sugar

cane, cotton, flax, hemp, abaca (manila hemp), sugar beets, and the like, but only the results dealing with production of a larger volume of the main body of the plants seem exactly comparable to the problem of faster volume production in trees. The production of cotton and corn is mainly concerned with the fruit. Sugar beet breeding is for the purpose of increasing the sugar content of the beet. However, some of the miscellaneous results are interesting as they may bear upon the possibility of changing the properties, qualities, or composition of trees.

That breeding is not all a simple procedure of easy pollination and routine compilation of the results can be illustrated by a few examples. Henry (22) found that careful attempts to cross four species of ash (*Fraxinus*) resulted in seedlings which so closely resembled the mother parent that they appeared to be examples of what Bateson called *monolepis*. Henry says that East observed similiar results in crossing species of *Nicotiana* and stated that " these seeds (of the attempted cross) must have resulted from apogamy or polyembryony, *i. e.,* from development of an immature egg cell without fertilization." Henry states that " the occurrence of the phenomenon in *Fraxinus* is very *embarrassing.*" Apparently this is another factor to be reckoned with in tree breeding. It may prove baffling if very common and will appreciably slow up the work.

Kempton, having noted some variations from the expected Mendelian ratios, has collected interesting data (28) from a number of sources with the hope of throwing some light on the matter. When a certain character is found to have been transmitted to a smaller number of offspring than the Mendelian ratios indicate should be produced, it has been thought that it could be accounted for by the assumption that the gamete with the gene of that factor was at a disadvantage in effecting fertilization in competition with the gamete bearing the dominant allemorph. In this paper it is stated that Bond obtained different ratios in peas when he pollinated mature and immature stigmas. Pollen upon the immature stigmas no doubt went through the equivalent of a storage period before it could effect pollination. The storage of maize pollen under various conditions was carried out by Kempton, and variations did attend the use of the different groups of pollen in breeding.

The vigor of growth of pollen tubes, the effect of storage on the vitality of pollen, and the fact that the presence of a gene for a certain character in the gamete of maize is associated with a demonstrable chemical change are features of breeding work that need further study. The failure to accomplish crosses among the ashes may not only be explained but remedied by a better understanding of the qualities and reactions of pollen. No doubt many difficulties attending hybridization will remain unsolved until more is known about the process of pollination and fertilization.

Selection

No program of breeding would seem to be complete without some consideration of the matter of " selection," though " selection " is not breeding in the strictest sense. Early breeding work seemed to show that selection might be the solution of many difficulties. Rather famous in this respect is the selection described by Smith (40) and Richey (37).

One variety of corn was selected through 13 generations in an attempt to develop seed with high and low oil and protein content with results as follows:

Year	Oil content		Protein content	
	High	Low	High	Low
1896........	4.70	4.70	10.92	10.92
1908........	7.19	2.39	13.94	8.96

This experiment seemed to put pure selection in a very strong position, for by selection a considerable change in properties was achieved. The next year, however, Pearl and Surface (35) published the following statement: "The chief, if not the entire function, of selection in breeding is to isolate pure strains from a mixed population. It is found impossible to bring about by selection improvements beyond the point already existing in the pure (*isolated*) strain at the beginning." In other words, intelligent breeding *plus* selection would probably accomplish or exceed the results of pure selection and do it in a shorter period of time.

Richey states that practically all of the present varieties of corn have been produced by mass selection, and he feels that it has its place, at least in maintaining yields. The development of ear-to-row[1] selection for corn at first appeared superior to mass selection, but he says "there has been no evidence of a cumulative increase in yield under continuous ear-to-row selection." This lack of cumulative increase is the weak point in any form of pure selection.

The real place of selection, it appears to me, is given in Richey's statement ". . . . plant breeding consists essentially in hybridizing to create new combinations from which to obtain the best by selection." This means that since the forest tree breeder desires the rapid growth resulting from hybridization, and probably will desire to discard the hybrids that do no better than the parents in growth rate, hybrid seed can be planted in a nursery bed, and the most vigorous seedlings resulting can be selected and used for planting. After finding suitable hybrids, areas of parent stock could be established and the hybrid seed could be produced by natural or artificial cross fertilization.

The Factor of Cost

The mention of planting brings up the question of planting costs, which, for many areas, have been considered as higher than the estimated returns at the end of the rotation would justify. Rapid growing trees will, naturally, bring quicker returns than slow growing trees and for that reason would shorten the rotation and the period during which compound interest is active. The extent to which this will influence planting costs and allow for higher initial investments is illustrated below. If we assume that land is worth $5.00 per acre, the cost of the stock and the planting together is $10.00 per acre, the yearly expenditure for taxes and protection is 5 cents and 3 cents respectively per acre, and interest is 4 per cent per year compounded, the following approximate total costs would be charged against the plantation:

[1] Ear-to-row selection means planting the seed from one fruit (as ear of corn) in one row or part of a row and another like set of seed in the next row, etc. The purpose in this was to keep separate records of each parent and their offspring, and avoid the mixing that takes place in "mass selection" methods.

APPROXIMATE COST OF A 7 x 7 PLANTATION AT VARIOUS AGES

Rotation	Original cost,[a] planting and land	Yearly costs, taxes and protection	Total costs	Cost in per cent of 80-year cost
	Dollars per acre			
Years				
20	27.20	2.48	30.28	7.9
30	43.55	4.49	48.05	12.5
40	67.00	7.62	74.62	19.4
50	101.85	12.21	114.06	29.8
60	153.00	19.10	172.00	44.7
80	341.00	44.15	385.15	100.0
100	753.00	98.90	851.90	221.5

[a] Cost of land, $5.00, deducted at end of rotation.

For the purposes of illustration, 80 years has been picked as an average rotation for the country as a whole. It then appears (right hand column) that a reduction in the rotation of 20 years or 25 per cent (from 80 to 60 years) effects a reduction of 55.3 per cent in the costs. A reduction of 30 years or 37½ per cent (from 80 to 50 years) effects a reduction of 70.2 per cent in costs.

The hypothetical nature of these particular figures does not alter the fact that more rapid growth will materially reduce the cost of growing timber, whether it is naturally or artificially established. If a tree can be produced that will grow as much timber in 50 years as its parent stocks do in 80 years, we could theoretically afford to spend almost twice as much as the cost of establishing the parent stock to establish a stand of the new stock. And even then, at the end of its rotation, the new stock would have produced as much as the parent stocks at the end of their rotation, but the final cost as shown in the table would be, altogether, only a bit more than half as much. This would seem to indicate that in such a case we could advantageously replace many planted stands that are growing slowly or moderately at the present time, and further do planting on areas where planting does not now pay, because the best present growth is too small to furnish reasonable income.

Unless some trees can be bred "true" (and this may never be a development worth the effort) it appears that we shall be obliged to replant our hybrid stands at the end of each rotation, for if we allow natural regeneration, genetical experience indicates that the second generation will be very mixed, lose a great deal or all of its hybrid vigor, and in general prove unsatisfactory. Experimentally such an area of second generations would prove exceedingly interesting and valuable as a source of new varieties, which could be selected as parents for new crosses. One of the greatest needs at the present time is for some such area where various relationships can be studied over a long period of time.

HYBRIDS, DISEASE RESISTANCE, AND IMMUNITY

In many cases a hybrid not only makes more rapid growth than the par-

ent but may also be more resistant or, we hope, even immune in some cases, to diseases that attack one or both of the parents. This characteristic has already proven of inestimable value in numerous agricultural crops, when rusts, smuts, wilts, and the like have become prevalent. Kearney (27) states that by 1900 breeding is said to have produced two varieties of cotton that were thoroughly wilt resistant. Hartley (19) has discussed in considerable detail the relation of genetics to disease resistance in trees. Disease resistance was mentioned by Sudworth (41) as one of the phases of tree breeding that needed study, and, whether consciously or not, he placed it at the head of a list of tree breeding problems. Henry (23) in discussing hybrids states that they "are to a considerable degree immune from serious attacks of insects and fungoid diseases." Pathologists are now attempting to obtain blight resistant chestnuts by crossing exotic forms with our own chestnut. Lookout is also kept for any chestnut sprouts appearing in the blight region that may appear to be resistant. White pine blister rust can be controlled by ribes eradication but a resistant species would be very helpful, and eliminate at least a part of the large sums now expended in control measures.

Though not much is known about the recently discovered larch canker, the fact that it has been found to attack Douglas fir might mean that its chance introduction into the Douglas fir region would be followed by losses that would be in the nature of a national calamity. Such an introduction may be inevitable, but if it could be sufficiently delayed the development of a resistant variety of Douglas fir might be possible; if so, it would be worth untold sums of money.

There is less evidence that trees may be developed that are resistant to insects, though it would be highly desirable to produce them. Bates (6) noted that in one plantation there seemed to be sufficient differences between western yellow pines of varied geographical seed sources to cause some browsing animals (probably deer) to feed upon some and reject others after sampling. If an animal may be drawn or repelled by some taste or quality in a tree, why may not insects, also? Various chemicals and other substances are now being tried with western pine beetles with this idea in mind. It has been stated that a solution of aloes introduced into a white birch infested with bronze birch borers apparently caused the borers to leave the host tree. These phases give almost unlimited leads for study and experiment. The number of insect pests attacking the forest trees of this country and the resulting damage mean, as before intimated, that breeding trees for resistant characteristics may at some time take precedence over breeding them for more rapid growth.

Seed Source

The source of the seed from which comes stock to be planted on a particular site is worthy of much study. The United States are of such an area and have such varieties of climate, soil, elevation, and other site factors that "geographical" strains of certain tree species have apparently formed. In the case of western yellow pine these differences are great enough to have resulted in several attempts to divide at least two of the geographical strains into distinct species. Thus it is apparent that the geographical source of seed may be an important fac-

tor in a source of seed study. It has been suggested, in connection with some of the tree breeding work, that accelerated growth might result from introducing trees and seed of certain strains from a northern region or high elevation to a more southern region, or one of lower elevation, provided soil and moisture requirements could be met. This may prove successful if the maximum temperature and resultant transpiration are not too great. Moving stocks to higher latitudes, however, has resulted disastrously. In this connection some of the results of European experiences in introducing trees to new regions are of interest.

Eckbo (16) states that experiments by European countries with Scotch pine and Norway spruce have invariably shown that "seed from the north or high elevations produce trees with a poorer development in the south or at a lower elevation than trees from local seed. Furthermore, it has been proved that seed from a high altitude is far superior to lowland seed (*for planting*) in the mountains." Scotch pine brought into Germany from Scotland proved to be so entirely unsatisfactory that further importations were forbidden by law *to protect the public.* Eckbo states that, as German foresters supervised the first forestry projects in Scandinavian countries, a good deal of German seed and planting stock was introduced. The seed and planting stock were first class, but the plantations that resulted were either failures or made good growth only in good seasons. Those trees that lived were so crooked by the time they had reached pole size that they brought only a small return for fuel.

Origin of seed N. Latitude	Number plants	Condition of plants		
		Number alive	Number dead	Per cent dead
50° 35′	674	2	672	99.7
57° 47′	1296	7	1289	99.5
57° 38′	156	1	155	99.4
58°	942	12	930	98.7
58° 11′	714	6	708	99.2
58° 39′	582	38	544	93.5
58° 50′	600	14	586	97.7
59° 13′	524	63	461	88.0
60° 8′	181	128	53	29.3
60° 48′	455	428	27	5.9
60° 50′	400	368	32	8.0
61° 35′	185	181	4	2.1
62° 50′	225	223	2	0.9
64° 15′	420	414	6	1.4
65° 15′	455	442	13	2.9
65° 55′	300	295	5	1.7

This is also an example of the length of time that one may have to wait to determine whether a species will prove satisfactory or not.

To my mind one of the most interesting parts of Eckbo's article is the preceding table prepared by Gunnar Schotte, formerly director of the Swedish Experiment Station, showing the survival some five years after planting of Scotch pine trees growing under "identical conditions" but produced from seeds that came from different latitudes. The nursery where the study was made was in latitude 65° 40′ and the table presum-

ably shows the maleficent effect of moving the seed (except the last lot) farther north and growing it under more severe conditions than the parent trees were inured to.

Though information upon the relation of seed sources and nursery site as to elevation, climate, soil, etc., is lacking, this table seems clearly to indicate the care foresters must use in introducing trees into higher latitudes and higher elevations than those of the seed source. A comparable study to show the results obtainable from bringing seed of various latitudes in this hemisphere *south* to a single nursery, and raising the trees, would throw valuable light upon the opportunities for increasing growth by introducing trees to milder climates. It is naturally essential to ascertain that the trees can *survive* well before any extensive program of any kind is started.

A great many American trees have been introduced into Germany. The results are interesting, but are not definitely enough associated with site and climatic data to give a basis for judgment and comparison or to furnish conclusions applicable to this country. Prof. Drude has divided Germany into eight climatic zones, which might be used for judging exotics in the future. Douglas fir (1) is said to have done well in all forests, except on sites of "great dampness" of soil, or where exposed to high winds. Only seed from the west slope of the Cascades from the forty-fifth to the fiftieth degree of latitude is recommended for importation, however. Black locust has been introduced for a long time, has spread greatly, and may be considered indigenous. It apparently grows almost anywhere in Germany.

Western yellow pine, common on such a large area and varieties of sites in this country, "does not thrive uniformly" in Germany. Climatic conditions in the north are unfavorable. This is hard to understand if one considers the severity of the climate in the northern Rocky Mountains where this tree is found naturally. Red cedar (*Juniperus virginiana*) also finds an adverse climate and is almost a failure. On the other hand, tulip poplar (*Liriodendron tulipifera*) "is found everywhere" and apparently does well. These examples of exotics in Germany seem to show a number of anomalies; for example, why should Douglas fir from the northwestern part of the United States and tulip poplar from the southeastern part succeed when species with such a wide range in the United States as western yellow pine and red cedar fail?

There are many reasons, however, for giving a great deal of attention to the source of forest tree seed. Genetics show the value of raising the standards or average qualities of races by concentrating upon good individuals and eliminating the poor ones. Studies in the inheritance status of good and bad qualities in forest trees will give us a basis for selecting seed from such sources that the quality of resultant stands can unquestionably be improved. Selection by various means and artificial pollination by hand or by arrangement of the trees will accomplish much of this.

Mass selection at first glance appears as a somewhat unscientific way of improving the quality of a crop, partly because the seed of the selected individuals are sowed together so that records of individuals are lost in the mass, and partly

because the mixed hereditary characteristics of these individuals are practically ignored. Selection of various kinds, as previously pointed out, has its place in the scheme as an adjunct of true "breeding." It also can be said that selection is important in its relative simplicity, and in the fact that it undoubtedly can be used to increase yields up to a certain point, and thereafter help to maintain them. In selection one strives to eliminate the poor individuals, and the strain of poor quality under proper treatment is therefore decreased in the selected line.

Selection in tree breeding work has been suggested to apply in three ways—selection of trees, selection of seedlings, and selection of seed. All three of these forms of selection are of interest in a study of seed sources. In other words, tree breeding and seed sources studies overlap in places.

Tree, seedling, and seed selection are also pretty closely linked together. In tree selection one would pick the most promising trees and use their seed, upon the assumption that the seedlings would show the promising qualities of the parents. In seedling selection, whether the seed used was from a selected source or not, the best seedlings would be chosen for planting on the assumption that those showing the greatest growth rate in the seed or transplant beds would be likely to show the most promise when planted out. In seed selection there is considerable vagueness, for it is practically impossible to tell, by any means that we know of, what to expect from forest seed in regard to quality, growth rate, general vitality, hardiness, and the like, though Munns in two studies of the seed of Jeffrey pine obtained information that appears pertinent. He found (34) that large seed and seed from large cones germinated much better than small seed and that from small cones. This, as he intimated, suggests the possibility of sorting out the big cones by means of screens to obtain better seed. It has often been stated that large seed would also produce more vigorous seedlings. Cieslar (8) found that oak seedlings from large acorns were appreciably faster growing than the seedlings from the smaller acorns, but states that this advantage evidently disappeared by the time the trees had reached about 18 years of age. It would seem, however, that one could judge seed better by going back to its source and studying the parent stock, than by any inspection, study, or tests on the seed itself.

Presumably selection of seed from the most rapid growing, well-formed, healthy trees, followed by selection of the most rapid growing seedlings resulting from the sowing of these seeds in the nursery, would give us satisfactory planting stock. But there are difficulties in the way of carrying out this scheme. In the first place, which are the most rapid growing trees in the stand? Increment borings and measurements may be needed to determine age and volume as a gauge of growth rate. If one of the most rapid growing trees can be determined, one cannot be sure that the seed it produces did not result from pollination of this tree by pollen of a poorer individual in the stand. This factor is the main reason for further selection when seedlings have been raised from such seed in the nursery beds. If a stand can be found or grown in which the trees are all more or less of equally good quality and of even age and height a more uniform quality of seed could be produced. In spite of think-

ing that we would know a good source of seed if we saw one, and we did find it, we would be faced with the difficulty of producing the seed on a commercial scale, for this would distinctly be desirable though not essential. For one thing, the cost of collecting the seed would be considerably higher than in an operation where, as is often the case, most of the cones are taken from squirrel caches, from felled trees, or are raked or cut from low stocky trees. Any one who has ever tried to collect seed from tall trees could tell of the hard labor and danger attendant upon the work. Stands of high quality seed trees are none too numerous or extensive, especially if one wishes pure stands.

It is fairly easy to obtain good seed source data for small quantities of seed. When, as in 1911 (17) the Forest Service collected 161,880 pounds of seed, the problem of collecting seed alone becomes stupendous, without any additional burdens of detailed records and labor that would follow from trying to obtain seed source data. The change from direct seeding to planting nursery stock has, of course, greatly reduced seed requirements, but seed collection is still a big business, so much so that detailed studies have been put off. Zon (43) has shown the difficulties attendant upon getting definite information for the collection of ordinary seed. When one is attempting to collect seed that is of a strain above the average there will be still further complications. Phenological observations will become more and more valuable as time goes on, and more attention will be given to watching seed crops develop so that estimates of the amount and quality of seed obtainable upon maturity will be available.

Certified seed is sometimes spoken of. We might apply this name to seed of a known source and a certain standard of quality, which name could be used to separate it from ordinary seed. Certified seed to carry out the purpose of improvement in tree growth should be certified for a number of qualities. The buyer of the seed, who will probably have to pay more for it than for ordinary seed, will want to be sure that it is enough better to be worth the additional cost. The seed should be certified as coming from better than average seed trees. It should be of good purity, clean, should have been extracted under conditions that will not impair it, and should have a good germinative capacity such as is representative for the species when germinated by some standard method to be specified. To have good germinative capacity after a period of storage it will have to be stored in a way that proves the best for the seed in this respect. The buyer also will probably want to be assured or guaranteed that the seed is definitely that of the species or the variety that he has asked for.

The Germans (12, 13) have been attempting to work out a system of suitable seed certification for several years. They have developed what might be interpreted as a Central Committee for Forest Seed Certification, with representatives of a specified character, mostly foresters. Seedsmen and nurserymen have a representation also, and there are local committees for the districts. Areas of suitable seed sources are investigated by the committee, and those that are certified are published in lists, giving the name of the area, the district, the forest, the kind of seed, the name of the owner, and the size of the area. Members producing or dealing in certified seed undertake to guar-

antee the character of the seed, ship it under seal, keep the seed from mixing or being mixed with other seed, report on the progress of the new seed crops, and see that the crops are used if possible and not wasted. Members dealing in planting stock derived from certified seed assume similar obligations. Names of members and firms not living up to the requirements are published.

Any system of seed certification that approaches the ideal will have to furnish more information than just that as to the source and quality to be expected. The Danish Seed Control Station (31, 32), probably one of the oldest of its kind, dealt at first with agricultural seeds but of late years has given considerable attention to forest seeds. According to Larsen its analysis of seed embraces a determination of genuineness, purity, weight, vitality and germinative power, amount and character of foreign material, number of seeds per pound, water content, and dry weight. The rules and regulations governing seed analysis are definitely standardized and no station guarantee is given when partial analysis, only, is asked for.

Some definite system of carrying out germination tests is absolutely essential in any seed testing laboratory, and in any program dealing with producing seed of a known high quality. It may be necessary to have variations to adapt the system to all kinds of seed. The seed-testing laboratory of the Bureau of Plant Industry at Washington (oral information) has found that for a satisfactory determination of germinative capacity some seeds can be left for all the germination period in apparatus similar to a Jacobsen (31) germinating apparatus, while other seeds should be moved from the warm day-time germinator to a cooler chamber for the night. Temperature ranges and other factors for various species of forest tree seed may have to be worked out and specified for standard germination tests; for instance, procedure No. 1 may apply to white pine, spruce, and fir, while No. 4 is standard for basswood, No. 5 for locust, etc. Some scientific data should no doubt be secured to see if a correction factor can be applied to seed that have delayed germination or are otherwise stubborn. Snipping the end of the seed coat is practiced in some tests, placing in hot water, scratching the coat, or freezing in others. There seems to be very little correlation in many of the tests. Methods, in addition to the determination of the best ways of storing seed, can perhaps be worked out to improve the effective germination of seeds, both in the laboratory and the field. The Jacobsen germinating apparatus (31) appears to be the best to date. Effecting as good germination in the field as in the laboratory would be a valuable achievement.

Some foreign germination tests are carried on with the idea of obtaining the maximum germination possible in the laboratory—the seeds may be coddled, and even a seed that breaks the coat and then dies is counted as one that has germinated. This appears to defeat the idea of the test which is to obtain a gauge of what may be expected of the seed when it is planted out-of-doors. There is, then, no advantage in finding some new way of bringing forth unusually large numbers of seedlings in the laboratory unless we can do the same outside. There is, however, a distinct reason for having a *standard, uniform* means of germination as a basis for judging the germination to

be expected in the field. Munns' work (33) in cross- and self-fertilizing various combinations of vigorous, suppressed, and mistletoe-infested trees of Jeffrey pine shows that vigorous trees produce seed with much the best germinative capacity, that suppression of either parent reduces this capacity in the resultant seed, and that cross fertilization apparently has a slight advantage over self-fertilization.

It is perfectly possible that there may be qualities of disease or insect resistance, of wood, or of growth rate that may be discovered in some of the geographical or other strains of our present recognized tree species. Buyers may wish to obtain seed that will have these hereditary qualities. The question will arise at once, what qualities are hereditary, what are environmental, and what are, we might say, purely individualistic. Though there is no doubt that a great deal of general observation more or less connected with these details has taken place, specific information is generally lacking. It is difficult to determine to what extent heart rot in a tree may affect the offspring of that tree. What is the hereditary tendency in a coniferous tree that has a forked trunk contrary to most of the individuals of its species? To what extent is susceptibility to insect attack hereditary? Are drought resistance and hardiness transmissable qualities in all cases? Have we dwelt too much upon the qualities of the part of the tree above ground, while knowing too little about the part below ground? These are only a few of the problems that arise when one attempts to clarify in his mind the problem of seed source.

It appears that it will be necessary to compile all the available information that deals with the relation of seed tree to offspring, and in addition, urge scientific observation upon those who are so situated that they may be able to add to present knowledge. This should be followed by, or correlated with, actual seed collecting, nursery work, and planting carried out with the primary intention of checking or enlarging our knowledge. It is probable that the studies of seed source, resistance of various strains to disease and insects, selection, and tree breeding may be carried out more or less together at various geographical points in the United States where the trees can be worked within their native ranges.

Kræbel (29), in a preliminary report upon a study of Douglas fir seed, has drawn some tentative conclusions from early results obtained. In abbreviated form they are as follows: (1) Gather cones from a locality as cold as or colder than the planting site. (2) Collect from open grown tree where practicable. (3) Seek large cones. (4) Collect from young or middle-aged, medium or large trees. (5) Avoid trees growing on poor soil. (6) Avoid high altitudes unless the planting is to be high. (7) Avoid fungus-diseased trees. (8) Avoid insect-infected cones. These general conclusions are only an example of our somewhat meagre knowledge of these problems.

Vegetative Propagation

Vegetative propagation by means of grafts has already been mentioned; in addition there is propagation by means of cuttings, layers, and the like.

Cuttings, commonly, are only used in forestry for the propagation of willows and cottonwood. The use of cuttings for growing other species has been limited by the costliness, the impracticability, or

the impossibility of making the cuttings produce roots and grow. Nurserymen and horticulturists have been able to reproduce most of the arborescent species by means of cuttings, but their methods have not been applicable to the forester's needs.

Cion and bud grafts, layers, bulblets, and cuttings are the most important part of any propagator's means of reproducing a vegetative growth of a definite quality, especially when that quality is present only in the form of a sport, a mutation, or some similar variation. Vegetative propagation will produce growth like that from which it was taken much more nearly and more uniformly than seed reproduction. It will do so in a great majority of the cases. Bud variations, however, sometimes cause changes of a minor number that are occasionally important.

Bud variations that develop upon grafted stock are sometimes exceedingly detrimental in the case of fruit trees. Of interest in this connection is the work done with the Valencia orange (39). Twelve main strains, some producing abnormal shapes of fruit or leaves, and one producing unproductive (fruitless) branches appeared as the result of bud variations that reduced the quality of the fruit and the income obtainable from orange groves. It was noted that many orange trees "develop an excessive number of rank-growing, non-fruiting branches commonly called suckers." These suckers, perhaps because they appeared to have vigor, were generally used in the past by some propagators as the source of bud wood, as a result of which the characteristics of the suckers developed to a considerable extent in the Valencia orange orchards, and from 10 to 50 per cent of some of the orchards showed suckering strains. It is also stated in this same reference that "trees of several of the least productive and most undesirable strains have a very vigorous vegetative habit of growth. They often stand out conspicuously in comparison with the neighboring trees of the standard strain on account of their large size and dense foliage." This might indicate that bud variations that would occur from time to time in the vegetative propagation of forest trees, if such propagation becomes prevalent, might be selected to develop strains of more rapid growth, which might also be attended by partial or complete sterility. The sterility in this form of propagation would not be particularly detrimental to our purpose, and bud variations will probably be rare in forest trees. Orange trees are considered especially "sporty," however.

Grafting, though developed to a point in many tree fruits where it is relatively cheap, is still too expensive for application to our present reforestation work. In addition to the cost of the grafting operation itself, there is the cost of raising seedlings to furnish the root stock to which the cion is to be grafted. Unless forest crops increase very materially in value it does not seem that grafting will be used for this purpose for many years to come.

Some recent investigations carried out by Denny (14, 15) in attempts to break the dormancy of potato tubers and buds of plants seem to indicate that there may be some way of stimulating cuttings by the same or similar means. If cuttings of some of our more valuable species can be made to take root in some inexpensive and practical way, it should be relatively easy to select fast growing stock and pro-

pagate it for field planting. This fast growing stock could be used whether it was a natural seedling, a hybrid or a mutation. Even a part of the tree, similar to the sucker limbs of the orange trees mentioned, that grew faster than the rest of the tree and yet produced a good wood, could be extended by nursery means, until a sufficiently large volume was available for field planting. There would be but little need to worry about variation for the sexual reproduction that brings in the largest number of variations would be eliminated and only a relatively small number of adverse bud variations would be likely to occur. These could easily be noted and eliminated.

Conclusions

1. The study of forest genetics, heredity, and environmental effects upon trees is vitally important and is necessary for improved silvicultural practice.

2. Most studies in forest genetics will be essentially long-time projects, dealing with tree breeding and seed source.

3. In addition to developing rapid-growing strains of trees, investigators can attempt to develop strains resistant or immune to insects and fungi, or strains that have special qualities, such as birds-eye, high resin production, etc.

4. A widespread collection and correlation of records from parent trees to mature offspring is needed to advance our knowledge.

5. The ideal to work toward is to obtain well-established facts upon heredity, pollination, the function of various forms of selection, and the effect of environment, and finally to grow stands of improved timber.

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THE SOIL PROTECTION PROBLEM[1]

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WATERSHED protection may be separated into four main divisions: (1) protection of the water supply; (2) checking of floods; (3) checking of erosion to prevent the silting up of reservoirs and similar damage; and (4) checking of erosion to prevent depletion of the soil itself. Of these the fourth is in the long run the most far-reaching. The soil, after all, is the basic resource of the nation, since it is essential for the production of forage, timber, or farm crops. It may be correctly said "save the soil and you save all." Yet the problem of protecting the soil is so vast and so complicated and so little work has been done to obtain a full understanding of it, that this paper can do little more than give recognition of its existence.

The soil in the semi-arid west, especially on sloping lands, is not deep or particularly rich in those available elements essential for plant growth. The low rainfall characteristic of the region and the lack of glaciation have been conducive to slow weathering of the rock materials and to scant plant growth to help build up the soil. Moreover, the rainfall is of a torrential nature so that normal erosion of soil on the slopes of mountains and hills has been and continues to be rather high. By normal erosion is meant the general erosion or wearing away of the surface of the earth that occurs in spite of natural hindrances. A cover of vegetation finally became established in the past in spite of the normal erosion, until in most places the plant cover has been able to set up more or less of a state of equilibrium between the ever present soil-building and soil-destroying forces. The net result is the present soil mantle with its cover of vegetation, but ages have been required for it to be formed. Because it is so thin and so easily depleted it must be protected in order to be maintained.

The advent of the white man into this region some 80 years ago introduced the additional tearing-down factors of grazing, lumbering, and fire. These agencies have operated in two ways. Probably the most destructive effect has been a reduction in the amount of plant cover, thereby freeing the forces of erosion to tear down and carry away the soil from the slopes where it belongs at a much more rapid rate than under normal conditions. This is abnormal erosion. Second, has been the removal, either through consumption by livestock or destruction by fire, of a large portion of the plant material that otherwise would have been left to enrich and maintain the fertility of the soil. But little study has been given to the effect of the depletion of vegetation upon the fertility and productive power of the soil. That done, however, is convincing as to the destructive effects which follow.

On a typical area in the high plateau region of central Utah, where the aver-

[1] Paper given before Regional Forest Protection Board, Intermountain Region, Ogden, Utah, April 11, 1928.

age gradient of the slope is approximately 18.47 per cent and where the vegetation had been reduced by overgrazing to 16 per cent of a complete cover, it was found that the average net removal by run-off from summer rain storms of sediment or soil, exclusive of the amount held in suspension or in solution, amounted to 157.5 cubic feet from each acre each year over a period of 5 years. This is equivalent to about 8 to 9 tons of soil per acre being carried away each year. The eroded soil left on the slopes is incapable of producing a satisfactory forage crop. Chemical analysis showed it to contain less than a third as much nitrogen, less than half as much humus, only 67 per cent as much phosphoric acid, 85 per cent as much lime, and 87 per cent as much potash as similar non-eroded soil. Grass grown on the eroded soil required approximately 21 per cent more water to produce a pound of air-dry material than did grass grown on uneroded soil.

After 5 years of protection of the area against grazing, accompanied by some reseeding, the vegetation had increased until approximately 40 per cent of the ground was covered. This increase in vegetation resulted in reducing the erosion so that only 44 per cent as much sediment was being removed as formerly. In 1927, after 3 years more of improvement in the vegetation, there had been a farther reduction in erosion until in that year only about 29 per cent as much soil was removed as in the period when but 16 per cent of the ground was covered.

Another study on the effect of vegetation in retarding soil erosion has been made by the Missouri State Agricultural Experiment Station.[1] In this study the amount of sediment removed from bare uncultivated soil was compared with that removed from soil covered with bluegrass turf, on plots each one-eightieth of an acre in area, where the slope averaged 3.68 feet per hundred. It was found, over a period of 6 years, that the soil was removed from the bare area at the rate of 34.6 tons from each acre each year, while on the sodded area the loss was at the rate of only 0.3 ton per acre. This is in a locality where the rainfall is much heavier than in the Intermountain region, and the figures represent gross loss as compared to net loss on the area studied in Utah.

Conditions on other areas in the National Forests in Utah and elsewhere bespeak the evil effects of soil depletion. Many areas that were badly depleted by overgrazing prior to the establishment of the National Forests have failed to improve materially in spite of many years of regulated grazing or even total protection against grazing. Such improvement as has occurred consists chiefly of the coming in of short-lived annual and early perennial plants of little value for grazing. These plants, if adequately protected, serve their purpose in building up the soil so that eventually it will support a vegetation of higher value. Attempts to introduce forage plants by seeding on such areas have failed, evidently because of the depleted condition of the soil. Such attempts on uneroded areas, on the other hand, have for the most part been successful.

[1] Duley, F. L., and Miller, M. F. Erosion and Surface Run-off Under Different Soil Conditions. University of Missouri Agricultural Experiment Station Research Bulletin 63, 1923.

It is not difficult to observe the evidence of erosion where it has gone so far as to leave a system of shoe-string gulleys on the slopes and deep washes in the bottoms of draws and canyons. In some places such erosion has gone so far as to form "herring-bone" patterns on the side hills and to cut gorges from a few feet to over a hundred feet wide and as much as a hundred feet deep in what were once flat-bottomed canyons. Such erosion is more or less spectacular and is readily seen by the most casual observer; but in spite of its prominence it may not be the most destructive to the productivity of the soil.

Sheet erosion, which carries away only a little of the soil at a time but takes this from the entire surface of an area, is highly destructive. The gradual taking away process is so slow that it is often not noticed at all, but if allowed to continue will eventually deplete the soil and leave it comparatively unproductive for many years, or until nature can repeat her process of rebuilding. All of the facts relative to the rate at which sheet erosion is occurring have not been ascertained. In many places, however, close observation will reveal such indications as where old plants or other obstructions that have held the soil now stand up more or less on pedestals because the surrounding soil has been washed away. This is proof that destructive sheet erosion is occurring. Additional proof is offered by the increasing extent of washes and cutting in the bottoms of canyons and draws on overgrazed and unprotected lands in Utah and elsewhere. These indicate increased surface run-off, and where greater surface run-off is occurring there is but little doubt that greater sheet erosion is taking place.

There is a possibility also that the soil on grazing lands may be slowly depleted of its fertility even though erosion is not taking place. More or less of a popular idea has existed in the West that sufficient organic material is being returned to the soil on range lands to maintain its fertility. This may not be a safe conclusion. Studies in Europe and the eastern United States on pastures where there is fairly complete utilization of the forage crop each year have indicated the need for the addition of various kinds of fertilizer in order to maintain forage production. Plants of such low palatability as to be grazed but lightly or not at all by livestock frequently occur in mixture with the better forage species on range lands. The unpalatable plants are left to enrich the soil and undoubtedly help maintain fertility to a marked degree. On those areas, however, where most of the plants are of such high palatability as to be fairly closely eaten, there exists the same problem of soil depletion as on eastern pastures. It may be advisable on such areas to leave a certain portion of the herbage each year as a soil builder, since the lands are of such low value that the addition of fertilizer is out of the question.

The economic loss from erosion of the soil on western range and other lands has never been determined. It would be difficult to calculate. The one fact alone that soil depletion may be equivalent to a reduction of 21 per cent in rainfall indicates that the loss is enormous. In many places the problem does not appear to have become serious for it is known that there are places where the soil is still in good condition. However, this is not assurance that no damage is being done. The process is often so slow that

the injury may not be noticed for many years, but regardless of how slow, the eventual outcome will be soil depletion wherever more is taken away from the soil by erosion and crop removal than is added by weathering or plant decay. Moreover, the greatest loss, as indicated by studies on farm lands, may be in the removal of the essential chemical elements that go into solution in the run-off, so that their removal may not be noticed at all. The bulk of the land has been used less than 80 years, which, after all, is but a short time in comparison to the period it is expected the land will be used.

Protection of the soil will have to be accomplished largely by good forestry, the prevention of fire, and the application of proper grazing practices. Forestry that insures maximum production of wood may take care of the soil problem on forested areas. The need for protection against fire is obvious for many reasons. Not enough is known as to what grazing practices will take care of the soil. At any rate it is evident that abnormal erosion caused by overgrazing needs to be checked. More attention should be given to this phase than in the past. Grazing is being controlled on the National Forests with the view to checking at least the most obvious erosion, but there is no certainty that abnormal sheet erosion is being prevented in all cases. Some privately owned lands are probably being taken care of but others are in bad condition and getting worse. Much of the public domain is suffering from sheet as well as from gully erosion and will continue to do so until a system for its regulation is put into effect. Many phases of the problem require further study to determine just what needs to be done. That is a job for research, but the problem must be recognized before the research work will be undertaken. Those responsible for handling the various lands should be cognizant of its existence.

GRAZING AS A FIRE PREVENTION MEASURE FOR DOUGLAS FIR CUT-OVER LAND

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The Problem

CUTTING, slashing, and burning of timber in the clearing of land for the purpose of making homes engaged the attention of America's earliest settlers. Grazing was the first agricultural step in subduing these lands to the plow. The use of logged-over land for the grazing of livestock is therefore no new theory in the United States. There was no thought then, however, of promoting reforestation; on the contrary, its prevention was urgently sought.

In the Douglas fir region west of the Cascade Range in Oregon and Washington, within comparatively recent times small areas have been cleared for farm purposes, while larger areas have been burned over for the purpose of creating pasture; this still continues to some extent. In this manner much valuable timber has been destroyed. The increased value of timber and rigid laws for the protection of our remaining forests as a result of an awakened public opinion have checked this, though especially among the older residents there seems to be deep-seated belief that this practice was and still is justified. Enormous areas of timber land have been cut over and are now in various stages of natural reforestation and reburn. The need of adequate protection to permit natural reforestation on cut-over lands, and to prevent them from becoming a fire menace to adjoining uncut timber, is unquestioned. The protection of cut-over lands from fire, however, continues to be an exceedingly difficult problem in the Northwest. "Rob the fire of its fuel" has become a byword. Any suggestion for the reduction of this natural fire hazard therefore merits consideration and trial.

The proper and economic use by livestock of the natural forage produced on cut-over areas offers one important means of reducing fire hazard, as well as converting a forest resource into valuable animal products. An additional reason for the use and development of cut-over timber lands for grazing purposes is the increasing demand for summer range. On the twenty-two National Forests in Oregon and Washington for several years past an average of 130 applicants have annually been denied range for 90,000 head of sheep and 4000 head of cattle, in excess of those for which National Forest range is available. With the development of new irrigation projects, many additional stock can be cared for during the winter season in excess of the number for which summer range can now be provided. If the increased rentals for summer grazing lands are any criterion, there is little reason to expect that the demand will be lessened as time goes on.

In spite of agricultural expansion, the fact cannot be escaped that for some time to come a large share of the privately owned cut-over land in the Northwest will remain in the twilight zone between

purely farm lands and forest-producing lands. The best authorities agree that with few exceptions even the better classes of cut-over land can well produce another crop of timber before being called upon for agricultural development. On lands of unquestioned farm value, grazing is the first and cheapest step toward cultivation of the land. As the first step, and often the primary motive for burning, there has been a prejudice against its use in connection with timber growing. On lands suited only to the growing of timber, if grazing is to be used in reducing hazard it is essentially good business to develop the type of management which will neither delay nor prevent reforestation.

Regardless of any difference of opinion between the farmer and the forester as to the ultimate use of the land, there is still a big question whether cut-over lands of this character, regardless of their ultimate use, cannot economically first support temporary pastures while the young crop of timber is developing. Can the area be grazed in a manner which will reduce the fire risk occasioned by the presence of heavy stands of fireweed and other transitory species without seriously injuring the future crop of timber? Will it produce a return from the land sufficient to meet the ever-increasing tax burden and interest charge? Can the livestock be moved from one area as it grows up to timber to other areas recently cut over and a cycle of grazing use thereby be developed somewhat comparable with the timber-cutting cycle?

Encouraged by the results secured by lumbermen and others in the use of cut-over land purely for grazing purposes and by success in the management of National Forest timbered ranges, answers to these questions are being sought by practical tests, which were initiated in 1925, with sheep on cut-over range on the Columbia National Forest in southwestern Washington. Study of Douglas fir cut-over range in Oregon used by cattle is likewise being made.

Description of the Region

An excellent picture of the region and the conditions which prevail is given by T. T. Munger in his recent bulletin on the Douglas fir region.[1] It will not be necessary to repeat his statement here, but it is important to emphasize the figure of 4,000,000 acres given in this bulletin as the area of cut-over land up to 1927. This vast acreage is in various stages of reforestation and reburn, though a small percentage of the better lands have been converted permanently to farm use. Over 200,000 acres are annually added to the cut-over area. These figures alone give some idea of the magnitude of the problem of fire protection.

Vegetation on Cut-Over Areas

Some idea of the vegetation found on cut-over lands is first necessary to a proper understanding of the problem. In the original type, untouched by the axe, an understory of shrub and herbaceous vegetation occurs, the principal species being salal (*Gaultheria shallon*), Oregon grape (*Odestemon nervosa*), huckleberry (*Vaccinium ovatum* and others), and various herbs and mosses. These species are largely unpalatable to livestock.

[1] "Timber Growing and Logging Practice in the Douglas Fir Region," U. S. D. A. Bulletin No. 1493.

Cutting and removal of the timber and the subsequent slash burn result in material change immediately following the slash fire; the vegetation is reduced to the same elementary stage found on bare rock, certain club mosses and liverworts first appearing.

The ashy and highly fertilized seed bed left by the fire is ideal for the reception and germination of wind-blown seed. The second or third year after the slash burn, the area is completely covered with a dense, vigorously growing herbaceous vegetation composed principally of invading species such as fireweed (*Chamaenerion augustifolium*), hawkweed (*Hieracium albiflorum*), and groundsel (*Senecio vulgaris*), all of which are palatable to livestock. This vegetation is interspersed scatteringly, sometimes frequently, with coppice from such shrubs as vine maple (*Acer circinatum*), huckleberry (*Vaccinium ovatum* and others), and blackberry (*Rubus ursinus*), whose root crowns have survived the slash fire. Perennial weeds and grasses, shrub species, and tree seedlings become more permanent in the type as time goes on. The rapid change as well as the abundance, height, and density of this early vegetation is a most striking phenomenon.

It is during this early stage, because of the accumulation year after year of dense masses of dead vegetation, that Douglas fir cut-over areas are highly inflammable. Reburns are peculiarly harmful, not only eliminating tree seedlings but destroying other vegetation, and resulting in rapid deterioration of the type, heavy increase in unpalatable bracken fern, soil impoverishment, and often serious erosion.

Use of Vegetation by Livestock Reduces Fire Hazard

Some idea of the reduction in fire hazard through grazing use will be gained from the average utilization of the vegetation found on 94 chain plots periodically examined in the experiment with sheep on the Columbia Forest. Fireweed, a highly inflammable plant, which averaged 40 per cent of the stand, was consumed 74 per cent; grasses and sedges were used 83 per cent; bracken, though mainly trampled, was used 14 per cent; and blackberry, considered of doubtful edibility at the start, was grazed 59 per cent. The average use of all vegetation removed by stock was 56 per cent. Trampling over the range and the establishment of trails were also found to be important factors in reducing fire hazard.

Unless an area bears the unmistakable earmarks of reburn in the absence of tree seedlings and a heavy cover of inflammable and unpalatable bracken, in 20 to 30 years after logging all other vegetation is often dominated by a thrifty stand of tree saplings.

Effect of Grazing on Coniferous Reproduction

To foresters generally this is the crux of the problem. Obviously if reproduction is sacrificed for grazing use, grazing as a cure for the fire problem is worse than the disease.

It is incidentally the most difficult phase to analyze and the most elusive of concrete results to date. Because of its complexity and the fact that in reality this is one phase of the larger problem of regeneration of Douglas fir, the examination and compilation of seedling

losses and damage have been made in close cooperation with the Pacific Northwest Forest Experiment Station.

Sufficient time has not really elapsed to state definitely the cumulative effect of grazing on reproduction, and it should be borne in mind that the problem is properly one of weighing any loss of seedlings against the benefits derived from grazing protection rather than the simpler one of numerically weighing actual losses sustained. The major difficulty from the start has been the paucity of tree seed crops and consequent germination.

Generally speaking we have had very light seed crops in the region since 1925, when the study was initiated. The data collected in 1925 and 1926 on 94 grazed plots in comparison with check enclosures brought out the interesting fact that better seedling survival (all ages) occurred on grazed than on protected plots. In 1925, for instance, 70.7 per cent of old seedlings survived on protected plots, whereas 71.75 per cent survived on grazed plots, the survival varying from 52.3 per cent on heavily grazed areas up to 84.8 per cent on moderately grazed.[1] The survival percentage for both heavily and moderately grazed areas in 1926 was likewise far in excess of that obtained on protected plots—85.7 per cent survival (all ages) for the moderately grazed as against 67.2 per cent for the heavily grazed and 41.25 per cent for the protected areas. The inclusion of plots where heavy germination and loss of hemlock occurred is largely responsible for these results. Segregation of the losses to determine the part grazing played was, however, impossible.

Because of the scarcity of seedlings and with a view to establishing controlled conditions the Pacific Northwest Forest Experiment Station in 1928[2] selected two plots which were sown in April, 1928, to Douglas fir seed. These were grazed during the summer of 1928 with the result that on one plot (Camp 9) out of a total of 63 Douglas fir seedlings germinating in 1928, 28 died from natural causes and an additional 7 (or 11 per cent) from sheep grazing, while 28 survived. On another plot (Camp 8) of 87 seedlings which germinated 25 died from natural causes, 3 in addition (0.34 per cent) were destroyed by sheep, and 59 survived.

On both these plots heavy grazing prevailed. On the Camp 9 plot particularly bedding conditions occurred.

While, as previously stated, it is premature for final conclusions from these results and from general study of the region, it seems safe to say that where moderate grazing occurs damage and loss of seedlings from this source are distinctly of minor consequence.

Seeding to Cultivated Forage Species

Since herbaceous vegetation of some sort, which is in reality a nurse crop for the tree crop to follow, follows as the natural sequence of logging, development of a more palatable type of vegetation which can be removed annually through grazing is frequently employed by land owners in this region. Seeding of cultivated grasses and clovers in the ashes of

[1] Ms. report, "Influence of Grazing on Forest Regeneration in the Douglas Fir Region," D. C. Ingram.

[2] Data obtained from Exp. Station report by J. Robertson, unpublished.

the slash fire or on the snow the winter following was one of the earliest measures used by settlers in this region in subduing the land and improving the pasture in connection with their farm operations. The practical results of grass seeding on a number of large operations indicate quite conclusively that seeding of cultivated forage species is practicable and profitable from a grazing standpoint. Excellent stands of forage have been secured which lasted from ten to fifteen years. Encroachment of shrub species gradually eliminates the sown grasses. Year-long grazing use and overstocking hasten this.

The study is conclusive that introduced forage plants give greater variety in the diet and are necessary to secure the closest and evenest use of the vegetation. This is important as a means of attaining the maximum fire protection which grazing will afford. Several companies seed their lands purely as a fire preventive measure, believing that grass species are far less inflammable than the natural vegetation which follows the slash burn.

There is, however, a question as to the competitive effect of grass seeding on the germination and survival of Douglas fir seedlings. Grass seeding certainly eliminates, for a time at least, a large percentage of competing shrub and herbaceous vegetation which would otherwise occupy the ground after the burn. It seems logical that this may likewise be true of the incoming tree seedlings. Whether or not grazing slows up regeneration is not definitely known. In numerous cases where forage seeding has been practiced, good stands of Douglas fir have ultimately resulted, from which it is concluded that the condition of the burn and reburn, rather than the competing vegetation, has in large part been responsible for any temporary absence of conifers. The importance of definite tests of grass seeding under known conditions of burn rests on this question of its effect on regeneration rather than as a test of its practicability in producing forage. Regarding this latter point, as already stated, sufficient tests have been made to prove conclusively its practicability and value from a grazing standpoint.

Costs of seeding vary between 50 cents and $3.75 per acre, depending on the kind and amount of seed used per acre and the type of country seeded. The species most commonly used are orchard grass, timothy, rye grass, white and red clover, meadow fescue, and velvet grass.

While sheep will use unseeded cut-over areas to advantage, the preponderance of weeds largely unpalatable to cattle makes grass seeding practically a necessity where the area is to be used by cattle.

Within the past two years seeding of cut-over lands by airplane has been attempted and found to be an economical method for large areas. Several areas, 1200 to 2000 acres in extent, in the Coquille and Wendling sections of western Oregon, have been seeded in this manner with marked success.

By means of a specially constructed hopper 6000 pounds of grass seed were, in one instance, scattered in less than eleven hours of flying time. The seed, a grass mixture, was sown at the rate of 5 pounds per acre, less than half the amount required in hand seeding. In every case so far a successful stand has been secured at a lower cost than under hand-seeding methods.

Seeding in the ashes as early as possible after the fall burn is desirable, if not essential, in securing a good stand. Airplane seeding has a marked advantage in the rapidity with which the job can be completed.

Class of Stock Best Adapted to Cut-Over Range

Where transportation costs to winter feed are not excessive, sheep are best adapted to use the type of feed usually found on Douglas fir cut-over ranges. Handled in reasonably large bands (800-1200 head), they appear to offer the most profitable possibilities. Cattle on a comparatively large scale (250-350 head) have proven successful in some instances where the cut-over areas have been seeded to grass species. Cattle in small bunches (2-25 head) from adjoining ranches grazing year-long are at present the principal users of Douglas fir cut-over areas. It is doubtful whether cattle in small bunches, and with year-long use, will ever be a profitable venture. Use of cut-over lands by small farm flocks in southwestern Washington under a cooperative plan has recently been inaugurated and gives every promise of success. There can be little question that sheep, by closer use of the vegetation, give greatest service in reducing the fire hazard.

Grazing Season

To secure best use of the forage, reasonably early summer use is desirable. Between May 1 and July 15 the feed is usually at its best. Prior to April 1 the vegetation, as a rule, is " washy " and has little nourishment. Heavy rains are also likely to occur early, which make handling of the sheep among the logs and débris difficult. Trampling and puddling also occur. Tender feed is necessary for ewes suckling lambs, and after August 1 fireweed and other vegetation becomes woody and is less relished by the ewes, though dry sheep thrive on it. Actual tests show that sheep can profitably be grazed on unseeded cut-over areas from season May 1 to October 15. With proper rotation, year-long use is possible on seeded areas. Use in conjunction with late summer range on the National Forests or elsewhere, and in conjunction with winter feeding, is probably the most profitable and desirable form of use. Year-long use of unseeded range without supplemental winter feeding is rarely profitable, and from a reforestation standpoint is undesirable.

Carrying Capacity

Douglas fir cut-over areas are particularly variable in grazing capacity, differing between seeded and unseeded and between recent and old cuttings. Any set figure presumably applicable to all sections of so large a region would therefore be meaningless if not misleading. In the Coos Bay region, where heavy burning and grass seeding is practiced, one cow to six acres year-long is not considered unusual. Sheep on seeded areas there have made profitable gains on less than half an acre year-long. These figures may be considered above normal for seeded areas for the region as a whole. There is a vast difference between the capacity of seeded and unseeded areas. Normally unseeded cut-over areas range in capacity somewhere between one-fourth and 5.0 surface acres per head per month for sheep, depending on type of vegetation found and on length of time after cutting and burning.

In the Columbia Forest experiment, the average requirement for sheep was .336 surface acres per head per month. Satisfactory gains were made by the stock during the period of use.

Length of Profitable Grazing Usefulness

The number of years grazing use is profitable varies widely as a result of the difference in site, and also as a result of the treatment following a single burn. Ten to fifteen years is considered usual where careful management and the closest utilization are effected. The relation of longer periods of use to ultimate reforestation has not yet been determined. Efforts, mainly along reburning lines, have been made to prolong this period of grazing usefulness. In the Coos Bay region where heavy burning and grass seeding are practiced on private land for the express purpose of producing pasture, the forage crop "plays out" in from nine to ten years. Palatable forage grasses and weeds are replaced by unpalatable plants and shrubs. Shrub and conifer encroachment precludes further profitable grazing use. Year-long grazing is undoubtedly a factor in shortening this cycle. Heavy burning is believed equally responsible.

Reburning is resorted to, following by grass reseeding, and the process repeated. Needless to say, this practice if long continued retards and finally eliminates reproduction. A rather futile hope that this will apply to the brush species also is responsible largely for this soil-impoverishing practice. The practice has brought grass seeding into evil repute among foresters, when as a matter of fact careful analysis would seem to indicate that reburning is to blame. Examination of a number of reburned areas has failed to show anywhere that the brush species have been finally eliminated by the seeding-reburning practice alone. On the contrary, among the outstanding indications which general study of the region has developed are: (1) That Douglas fir lands, short of intensive tillage practice, seldom remain permanently as forage-producing areas; (2) Given freedom from reburn, regardless of grazing use, reforestation is ultimately assured.

Expenses, Profit, and Loss

However desirable use of cut-over areas by livestock may be as a protective measure, it must first be profitable. Unless it is no stockman will use it. Profit in any business is influenced largely by the care and management given. This is no less true of the use of cut-over areas by livestock.

Actual gains made by lambs in the experimental band on the Columbia Forest over a four-year period give some measure of the profit which may be expected from the use of unseeded Douglas fir cut-over areas by sheep. These gains averaged a total of 23 pounds for the period grazed (June 1 to September 20), or 6½ pounds gain per head per month. Lambs at date of sale averaged 75 pounds, bringing for the three-year period a local f. o. b. price of 11 cents per pound. This was 1 cent above the Portland, Oregon, market at the time. The ewes, in addition, made good gains. While these gains are not exceptional, they are comparable with those made by this class of sheep on other forest ranges in the Northwest.

Losses during the first two years were slightly below normal (2 per cent). The third year, due to depredations by bear, losses were considerably heavier ($4\frac{3}{4}$ per cent).

The largest single item of expense and the greatest handicap in the use of Douglas fir cut-over areas by sheep from the winter range section east of the Cascades is the railroad shipping charge. In the Columbia experiment, this was over $550 for the band, which is 23 cents per head, or twice the season's grazing fee. To justify this additional expense, at current prices 5 pounds gain per lamb above normal would be necessary. This additional gain was made the first two years. The last two years show less than normal gains.

Experiments to date, it is true, do not indicate any marked superiority of cut-over ranges over others in this region. Making allowances for the newness of this type of range, it can safely be said that cut-over ranges similar to that found on the Columbia Forest are equal in productivity as summer ranges to those found elsewhere in the Northwest. As a rule, their use will be in demand from east of the Cascades by large flock owners who must ship only where more desirable summer ranges closer to their home ranches are fully occupied and scarcity of summer range develops. In the meantime, where winter pastures and feeding facilities are locally available, farm flocks can profitably be used to reduce the fire hazard until decision as to whether land best suited for agriculture is cleared for that purpose or another crop of timber is produced.

EFFECT OF THINNINGS IN SAPLING DOUGLAS FIR IN THE CENTRAL ROCKY MOUNTAIN REGION

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Introduction

THE object of the experiment described in this progress report was to determine the effects of thinning on sapling stands of Douglas fir in the Central Rocky Mountain region, where growth, owing to dense reproduction and poor soil, is usually slow. Some indication was gained, as well, of the extent to which thinning and cleaning of dense stands will materially reduce the length of rotation for tie or saw timber production.

Description of Plots

Two areas were studied, both in practically the same longitude and located on the eastern escarpment of what is known as Rampart Range. On one of these, at the Fremont Field Station of the Rocky Mountain Forest Experiment Station, 10 miles west of Colorado Springs, two plots, approximately 200 feet square, were laid out in 1917, of which one was thinned to a spacing of approximately 7 by 7 feet, and the other left in its natural state. The location is on a moderately steep north slope with an average gradient of about 40 per cent, and at an altitude of 9000 feet. The slope was partly burned over about 1858, and in 1917 the stand included dense sapling Douglas fir, intermixed with aspen, limber pine, western yellow pine, and Engelmann spruce. The surrounding virgin Douglas fir forest has been cut over since the plots were established. One corner of each plot contains a few of the larger mature trees. The average age of the sapling stand at the time of establishment was about 60 years.

The soil on this slope is derived from the Pikes Peak granite, and is a mixture of very coarse gravel and finer soil particles resulting from the disintegration of the granite, which, with the admixture of vegetal matter, has resulted in a shallow loam. The base rock lies close to the surface and is more or less impervious to root growth.

About 198 cubic feet of green timber in standing trees was removed in thinning, comprising 50.5 per cent of all the conifers and all of the aspen, or 35.4 per cent of the stand by volume. All of this material was used locally as fuel, and was regarded as without value commercially. The composition of the remaining stand was estimated as 77 per cent by volume of the original Douglas fir, 39.1 per cent of the spruce, 70.7 per cent of the western yellow pine, and 49.7 per cent of the limber pine. The thinned plot was calipered in November, 1917, and the check plot in June, 1918. In 1922 both plots were remeasured, all trees on the thinned and every tenth tree on the unthinned plot being tagged. The latest periodic measurement was obtained in May and June, 1927.

The second area studied is near the head of Jarre Canyon, 40 miles north of

the Fremont plots and some 30 miles southwest of Denver. The location is on a fairly uniform north slope, except for occasional small dry gulches between which are low ridges not exceeding a height of 25 feet above the gulch bottoms but forming short easterly and westerly exposures on the lower portions of the area. The average gradient varies between 20 and 30 per cent, and the elevation is about 6750 feet. The soil is similar to that of the Fremont area, but is deeper and richer by virtue of a heavier mixture of clay and loam running down to five feet and more in the small draws.

The stand at Jarre Canyon is representative of the Douglas fir type on northerly exposures in most of the foothills region of the Pike Forest below 8000 feet. This territory was heavily logged for ties and saw-log material about 1880, and it appears very probable that the combination of heavy cutting and surface fires, which kept the soil quite bare, was instrumental in starting these fairly continuous sapling stands of today. The average age on the plots, as determined from 39 trees, was 39.4 years. Mixed in with the dense and moderately dense stands of saplings are occasional poles and defective Douglas fir veterans which were purposely left at the time of logging. Western yellow pine, which is the south slope tree in this region, is found sparingly in mixture on the north exposures. Because of the dense sapling stand, the ground vegetation is sparse. Small aspen, willow, and maple clumps, occurring quite scatteringly, constitute the rest of the stand.

On this location four one-acre plots, each two chains wide and five chains long, running with the slope, were laid out in the fall of 1921. The plots are contiguous with the exception of a one-half chain isolation strip between the control and the heavily thinned plot. Plot 1 was left in its natural state; Plot 2 was heavily thinned to an approximate spacing of 8 by 8 feet; Plot 3 was moderately thinned to $6\frac{1}{2}$ by $6\frac{1}{2}$ feet; and Plot 4 lightly thinned to 5 by 5 feet. Actual thinning operations were carried on during the winter, Plots 2 and 3 being thinned by Christmas tree purchasers and forest officers, and yielding approximately 1300 trees at 15 cents a tree. Most of Plot 4, however, because of the light thinning, did not yield enough Christmas trees to enable the purchasers to make the thinning, and a special detail of forest officers completed the work in January, at which time all of the large trees on the plots were also cut. The brush was scattered, as it also had been at Fremont.

The first year's cutting, which was extended to the area around the plots, gave an exceedingly high net return of \$70.51 per acre. This represented the best cutting in the region, subsequent returns averaging a good deal less for the area covered progressively in thinning operations.

The original stand on all of the plots had been measured in September, 1921. During the following winter all of the remaining trees on the three thinned plots were again calipered. In the winter of 1924-1925 a complete remeasurement was made, at which time all trees on the thinned plots were permanently tagged, as was also every fifth tree on the control plot. Very little trouble was experienced in identifying the trees measured in 1922.

The examination in the fall of 1927 was made in order to put the two units of the project on the same periodic remeasurement basis. At this time two reproduction quadrats, each 20 feet square, were established on each of the six plots involved, in order to get some information on the rate and progress of reproduction in the original stand and under the various degrees of thinning.

Results of Observations

For both areas two periods of observation are involved. At Fremont the first period is 4¼ years for the unthinned plot and 4½ years for the thinned. The second period includes 5 years between 1922 and 1927, making a total of 9¼ and 9½ years upon which the results are based. Both periods on the Jarre Canyon area are of 3 years' duration, giving a total of 6 years.

Only those elements of growth are strictly comparable which have been reduced to an annual figure. The relatively short period upon which the data are based, especially for the four Jarre Canyon plots, must be kept in mind in any critical appraisal of the results. Tendencies are indicated rather than absolute performance through a rotation period.

All data have been reduced to an acreage basis, since the Fremont plots are but .92 acres in area.

Number of Trees

The number of trees in the stands originally and at the periodic measurements is given in Table 1.[1]

The thinned Fremont plot shows approximately double the increase in trees for the full period over the unthinned. There is some doubt whether the percentage of gain is truly representative because of the very large number of new

[1] Stand tables for the various plots have been worked up and are on file in the Rocky Mountain Forest Experiment Station office. In this discussion only summarized data are included.

Table 1

NUMBER OF TREES AT DIFFERENT PERIODS

	Fremont		Jarre Canyon			
	Unthinned	Thinned 7′ x 7′	Unthinned	Thinned 5′ x 5′	Thinned 6.5′ x 6.5′	Thinned 8′ x 8′
Original stand	1583	1448	2402	5063	4832	2831
Number cut	0	711	0	3573	3905	2238
Per cent cut	0	49.1	0	70.6	80.8	79.1
Stand left	1583	737	2402	1490	927	593
Per cent of Douglas fir	58.2	81.3	76.0	99.2	99.8	99.2
Trees dying—first period	11	1	310	50	15	22
New trees—first period	202	151	108	24	27	22
Stand at end of period	1774	887	2200	1464	939	593
Trees dying—second period	22	3	119	34	19	10
New trees—second period	24	19	17	33	27	20
Stand at present time	1776	903	2098	1463	947	603
Per cent gain over stand left	12.2	22.5	—12.7	—1.8	2.2	1.7

trees reported at the end of the first period, most of which probably were suppressed trees and others overlooked during the first remeasurement. The second period data for dying and new trees are believed to be more indicative of existing conditions. These show a pronounced increase in the thinned plot and only a small increase in the unthinned.

The periodic gain in trees on the three thinned Jarre Canyon plots is only 0.1 per cent, and there is a net loss of 12.7 per cent on the control plot. This is to be attributed almost entirely to the activity of the " pitch girdle " disease, which was found on 67.2 per cent of the Douglas firs on the unthinned area and on 33.6 per cent of the trees on the three other plots. Three-quarters of all losses on the control plot are due to this disease, which in the last three years has killed about 5 per cent of the trees in the stand. Thinning the stand appears to have checked the disease appreciably, partly because diseased trees were favored for removal, and partly because the rate of spread of the disease, which is favored by dense stocking, has been reduced. For all three plots 56 per cent of the past three-year loss is due to " pitch girdle," while but a fraction over 1 per cent of the total trees present in 1924 died as the result of attack since then.

The difference in stand composition on the two sites involved is indicated in line 5 of Table 1. Aspen is not included in these figures. In 1927, 953 aspens, only one of which was above 3.1 inches in diameter breast high, were tallied for the Fremont unthinned plot, while on the thinned plot 890 sprouts of the species reached a height of 4½ feet and better since 1918. In Jarre Canyon no aspens have reached a measurable size since cutting in 1921-1922, and only 51 are reported for the unthinned stand, all but 3 of these being 3.0 inches and less in diameter.

REPRODUCTION

During 1928 reproduction quadrats were established on all of the plots to determine the effect of the various degrees of thinning on the amount and survival of natural reproduction. Two quadrats were laid out on each plot and counts were made in the fall.

The results of these counts are presented on an acre basis in Table 2.

It is apparent that, even under the original stand, reproduction is plentiful on the thin soil at Fremont, and this bears out general results obtained in past reproduction studies in this locality. Opening the stand has resulted in a threefold increase, which guarantees a complete under-story on such sites.

The situation is different in Jarre Canyon, where no reproduction is found to be coming in under the original stand. Furthermore, the rate of its introduction, which varies more or less directly with the amount of space between the trees left, is too slow to assure complete stocking (natural losses considered) at the time the present stand is mature. The reason for this quite evidently may be attributed to the absence in the vicinity of large seed trees, which were pretty well cleaned out in past logging operations. This points to the desirability of leaving occasional veteran seed trees on such ground where a short Christmas tree rotation is to be practiced. It is possible that opening up of the sapling stand will result in increased seed yield by sapling and pole trees, but there is no definite assurance of this.

TABLE 2

REPRODUCTION COUNTS, 1928

	Fremont		Jarre Canyon			
	Un-thinned	Thinned 7′ x 7′	Un-thinned	Thinned 5′ x 5′	Thinned 6.5′ x 6.5′	Thinned 8′ x 8′
Reproduction since cutting						
1927 seedlings	544	926	...	54	109	164
1926 seedlings	327	817	...	...	...	54
1925 seedlings	...	163	...	...	...	...
Older seedlings	653	2341	...	...	109	...
Total seedlings since cutting	1524	4347	...	54	218	218
Per cent of Douglas fir in this group	100	96	...	100	100	100
Reproduction present at time of cutting	1688	544	...	327	708	109
Per cent of Douglas fir in this group	74	100	...	100	100	100

BASAL AREA

The original basal area for all four Jarre Canyon plots (Table 3) was very uniform, especially when contrasted with the total number of trees, which varied between 2402 and 5063. This fact tends to support the supposition that under full stocking total production is limited by the capacity of the site and an increase in number of trees is counterbalanced by a corresponding reduction in size. The size difference in the average trees on the plots will be brought out subsequently. It may be supposed, in the plot thinned to 5 by 5 feet, that a certain amount of overcrowding, especially as compared with the much lighter stocked check plot, resulted in considerably more suppression, which would tend to vitiate to some extent a strict comparison of results. However, since each plot or area which it typifies has a certain crown level in which the bulk of the crown lies, the capacity to respond to any releasing stimulus is believed to be very much the same regardless of the size of the trees.

After thinning, the heavily thinned plot had one-fourth the basal area of the check plot, and the lightly thinned a little less than one-half. During the first period the lightly thinned plot gained exactly twice as fast as the check, and the heavily thinned one and one-half times as fast. This rate of increase did not hold through the second period, but nevertheless all thinned plots show a net increase well above that of the unthinned. The percentages of increase in the last line of Table 3 indicate that a moderate thinning will serve as effectively in stimulating basal area increment as a heavier one. The fact that the percentage of annual gain averaged 3.29 per cent for Fremont and only 2.25 per cent for Jarre Canyon indicates that there was less crowding on the Fremont plots. That the thinning operation did not stimulate growth as quickly at Fremont as in Jarre Canyon, where the result was immediately felt, is indicated by the figures for net gain in basal area in the first period.

TABLE 3

BASAL AREA AT DIFFERENT PERIODS IN SQUARE FEET

	Fremont		Jarre Canyon			
	Un-thinned	Thinned 7′ x 7′	Un-thinned	Thinned 5′ x 5′	Thinned 6.5′ x 6.5′	Thinned 8′ x 8′
Original stand	63.75	68.37	88.87	94.89	86.99	85.12
Cut	...	19.96	...	52.04	61.55	62.75
Per cent cut	...	29.2	...	54.8	70.8	73.7
Stand left	63.75	48.41	88.87	42.85	25.44	22.37
Loss in first period	0.07	...	5.09	0.98	0.18	0.33
Stand at end of first period	73.66	58.30	93.30	51.70	33.48	28.52
Net gain during period	9.91	9.89	4.43	8.85	8.04	6.15
Loss in second period	0.11	0.08	2.29	0.88	0.63	0.35
Stand at end of second period	83.15	69.06	100.87	62.26	43.36	37.32
Net gain during second period	9.49	10.76	7.57	10.56	9.88	8.80
Total net gain	19.40	20.65	12.00	19.41	17.92	14.95
Per cent annual net gain based on stand left originally	3.29	4.49	2.25	7.55	11.74	11.13

DIAMETER

Table 4 summarizes the average breast-high diameter changes in the stands since the establishment of the plots.

The variation in average diameter between the different Jarre Canyon plots in 1921 was considerably reduced by judicious thinning and accelerated growth. The average annual net gain for the 5 by 5 foot spacing exceeded the gain of the check plot by about 36 per cent; for the 6.5 by 6.5 foot spacing the gain was 79 per cent, and for the 8 by 8 foot

TABLE 4

DIAMETER AT DIFFERENT PERIODS IN INCHES

	Fremont		Jarre Canyon			
	Un-thinned	Thinned 7′ x 7′	Un-thinned	Thinned 5′ x 5′	Thinned 6.5′ x 6.5′	Thinned 8′ x 8′
Original stand	2.72	2.94	2.60	1.85	1.81	2.35
Trees cut	...	2.27	...	1.63	1.70	2.27
Stand left	2.71	3.47	2.60	2.29	2.24	2.63
Trees lost—first period	1.05	0.40	1.73	1.90	1.47	1.67
Stand at end of first period	2.76	3.47	2.79	2.54	2.55	2.97
Net gain first period	0.04	0.00	0.18	0.25	0.31	0.34
Trees lost—second period	0.98	2.16	1.88	2.17	2.46	2.54
Stand at end of second period	2.93	3.74	2.97	2.79	2.90	3.37
Net gain—second period	0.17	0.27	0.18	0.25	0.34	0.40
Total net gain	0.21	0.27	0.36	0.50	0.65	0.74
Average annual gain	0.02	0.03	0.06	0.08	0.11	0.12

spacing 102 per cent over that of the check. The net gain has varied in direct ratio with the degree of thinning.

On the Fremont plots the net gain was practically nil between 1918 and 1922, owing mainly to the excessive number of new trees which had attained a height of 4½ feet during the interim. For the five-year period net diameter accretion on the thinned plot was considerably higher than on the unthinned area, and disregarding the first period results, the average annual net increment, which is believed to be more truly representative, has been .05 inch on the thinned and .03 inch on the unthinned, an advantage of 60 per cent in favor of the former. However, the rate of diameter accretion even on the thinned Fremont plot is less than that on the unthinned Jarre Canyon plot. While this is due primarily to a difference in site conditions, it may be partly due to the presence of a large number of aspens on both Fremont plots. Although these are not a serious factor in the canopy (the average diameter being but 1.82 inches), very likely they have some effect on the growth rate of the conifers.

Although net diameter gain gives an idea of accretion for the stand as a whole, it gives an erroneous impression as to individual performance, because the more rapidly the stand is regenerating and new trees are included in the tally, the more pronounced is the tendency for the average diameter to remain low. A study of diameter increases of all trees present on the Jarre Canyon plots in 1922, including those which have died since then, shows that the percentage of gain for these trees (arithmetically averaged) has been 10, 25.8, 35.7, and 35.7 in the order of decreasing density of stocking. For the 9½-year period at Fremont, the corresponding figures are 22.1 and 27.9 per cent. These data indicate for the former group that the trees on the moderately thinned plot are performing equally as well as on the heavily thinned plot.

A comparison was also made of the average accretion of all trees at Fremont between 5 and 9 inches in diameter, these being the advance trees of the general age class represented, which will eventually comprise the bulk of the mature stand. There were 71 trees in this group on the thinned plot and 74 on the check plot. Their average diameters at various stages were:

	1917	1922	Gain 1st period	1927	Gain 2d period	Total gain	Per cent total gain
Unthinned	6.10	6.44	.33	6.79	.35	.68	11.2
Thinned	5.97	6.41	.44	6.85	.44	.88	14.6

Since the average gain for the unthinned stand is 7.8 per cent, which is but 0.1 per cent less than that of the thinned, it can be seen that the larger trees have benefitted more, as a rule, by the thinning than have the smaller trees. This is probably due as much to inability of the younger classes to respond as promptly as the more vigorous trees to the shock of opening the stand, as it is to the fact that competition has been reduced.

A comparison of the effect of different degrees of thinning on diameter growth is shown by diameter groups for both sets of plots in Figure 1.

HEIGHT

The height growth since 1924 of most of the small trees (below 1 inch in di-

ameter) on the Jarre Canyon plots, as actually measured, is given in Table 5. The increase where the stand has been opened is even more pronounced than in diameter accretion. In the unthinned stand the small trees are as a rule badly suppressed, but appear to have an inherent capacity to take full advantage of improved light conditions, at least up to the age of 40 years.

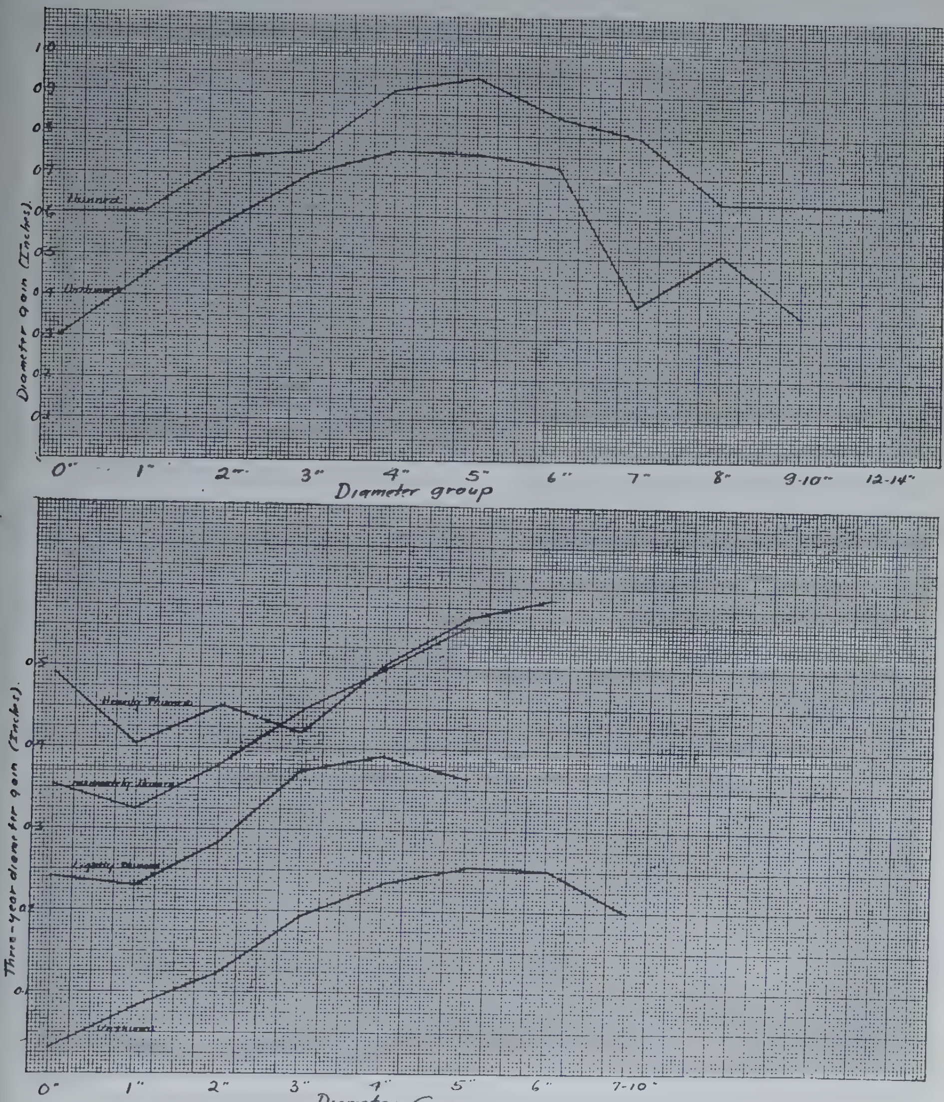

FIG. 1. Total diameter growth on different plots by diameter groups.
Above—Fremont plots, 1917-1927.
Below—Jarre Canyon plots, 1924-1927.

VOLUME

The original stands at Fremont were quite comparable in volume (Table 6). The total net increment for the first

TABLE 5

HEIGHT GROWTH OF TREES UNDER 1 INCH IN DIAMETER, BREAST HIGH, JARRE CANYON PLOTS, 1925-1927

Plot	No. of trees measured	Current annual growth (3-year period)	Maximum three-year growth	Minimum three-year growth
			Feet	
Unthinned	204	0.11	1.4	0.15
Slightly thinned	224	0.27	3.1	0.2
Moderately thinned	99	0.40	3.2	0.2
Heavily thinned	58	0.55	3.6	0.3

period was practically the same for both plots, again indicating the extreme sluggishness with which the thinned stand responded to opening. During the second period, however, it forged ahead, showing an increase of 15 per cent over the check plot. For the full period, the net annual increment on the thinned plot is but 1.22 cubic feet in excess of the unthinned plot.

In the Jarre Canyon group of plots the losses due to " pitch girdle " are seen to be very appreciable, although in the thinned plots cutting has reduced this damage. The original stand was heaviest on the plot thinned to 5 by 5 feet. In thinning, the stands left represented 47, 27, and 25 per cent of the total volume of the unthinned. In the first period all of the thinned plots exceeded the check in *net* increment, although the difference was small between the heavily thinned and the unthinned. When it is considered, however, that the former had only

TABLE 6

VOLUME AT DIFFERENT PERIODS IN CUBIC FEET

	Fremont		Jarre Canyon			
	Unthinned	Thinned 7′ x 7′	Unthinned	Thinned 5′ x 5′	Thinned 6.5′ x 6.5′	Thinned 8′ x 8′
Original stand	680.80	669.61	777.10	876.41	810.54	802.22
Amount cut	......	197.93	......	509.90	599.12	605.99
Per cent cut	......	29.6	......	58.2	73.9	75.5
Stand left	680.80	471.68	777.10	366.51	211.42	196.23
Loss—first period	0.51	0.01	40.76	7.70	1.32	2.64
Stand at end of period	787.99	579.90	840.95	455.19	288.52	260.75
Net increment—first period	107.19	108.22	63.85	88.68	77.10	64.52
Loss—second period	0.79	0.47	18.57	7.37	5.22	2.97
Stand at end of second period	893.30	701.46	911.48	561.90	388.18	352.92
Net increment—second period	105.31	121.56	70.53	106.71	99.66	92.17
Total net increment	212.50	229.78	134.38	195.39	176.76	156.69
Net annual increment	22.97	24.19	22.40	32.56	29.46	26.12
Per cent annual net increment	3.4	5.1	2.9	8.9	13.9	13.3
Total gross increment	213.80	230.26	193.71	210.46	183.30	162.30
Annual gross increment	23.11	24.24	32.28	35.08	30.55	27.05
Per cent annual gross increment	3.4	5.1	4.2	9.6	14.4	13.8

one-fourth the growing stock of the latter, this gain is surprising. During the second period the net increment gain for all of the thinned plots was considerably more than that of the unthinned. Six years after thinning, the respective stands now have 62, 43, and 39 per cent of the volume of the unthinned.

The highest annual net increment per acre is recorded for the lightly thinned plot. The moderately thinned and the heavily thinned, however, are well ahead of the other in per cent of annual net increment gain, and in this respect a moderate thinning appears to be as advantageous as a heavy thinning.

When annual gross increment is considered, the lightly thinned plot alone exceeds the natural stand, although the results are much alike, as they also are for the two Fremont plots. If for no other reason, thinning in the diseased Jarre Canyon stands proves its value in checking the spread of "pitch girdle" and reducing its destructiveness.

Conclusions

Drawing conclusions from the study may be rather premature, since the results of but 9½ years are available from the Fremont plots and of but 6 years from the Jarre Canyon plots. This fact must be taken into consideration in judging the relative value of the results. The following conclusions, however, appear safe:

1. The degree of thinning is largely a matter of management objective. For continued Christmas tree production on a short rotation, which will most likely appeal to the private owner, the widest spacing is most desirable, since it removes the greatest number of trees, gives the highest financial return, and insures rapid growth of the trees left. The importance of obtaining not only prompt but rapidly developing reproduction is self-evident where Christmas trees are to be produced on a short rotation and continuously productive soil is prerequisite. The relatively open condition resulting from heavy thinning insures ideal form for Christmas trees. It also leaves enough trees to protect the soil, which is a factor not to be overlooked, and apparently provides better conditions than lighter thinning for natural regeneration. A few mature seed trees per acre should be left, where any of these are present.

2. For a tie rotation, the moderate thinning is probably as effective as the heavier one, as far as this can be judged at present. It leaves approximately one-half again as many trees, and while it is to be supposed that a large number of these will be eliminated naturally before maturity, their presence will tend to clean the advance trees more effectively than under more open spacing. The present growth rate, which is only a little slower than on the heavily thinned plot, is equivalent to a 110-year rotation for ties. This product will most likely constitute the object of management on lands under Federal control.

3. In addition to its direct importance in utilization, thinning has been found a fairly effective measure for checking the spread of "pitch girdle," an unidentified bark disease which is very prevalent, attacking as much as 76 per cent of the sapling trees in the natural stand and being responsible for most of the losses.

REVIEWS

Foundations of Silviculture upon an Ecological Basis. By James W. Toumey, Professor of Silviculture, Yale University. *John Wiley & Sons, New York, 1928. Pp. xxv +438, 11 illus.*

Toumey's "Foundations of Silviculture upon an Ecological Basis" is already known to a number of foresters and plant ecologists through the mimeographed copies which have been distributed in three parts, comprising: Part I, The Site Factors; Part II, The Forest; and Part III, Methods of Investigating the Site Factors and the Forest Vegetation and Relating One to the Other. The first two parts have just come from the press, as Volume I, and the third part will be published later. The mimeographed form has well served its purpose in making the material available sooner than it otherwise would have been, and in affording the opportunity for revising the work in the light of various suggestions and of further investigations by the author and others. Those who know the mimeographed copies will want the printed book, not only because of the convenience of the contents and index, but because of the new material and improvements which make the work, already useful, now indispensable.

The main emphasis throughout the book is on understanding the natural forces, both external and internal, which influence the life of the forest, and on guiding these forces so far as we may towards the attainment of our objective. The author's viewpoint is expressed in the opening sentence of the introduction. "The natural, unmanaged wild forest in all its stages, from the denuded site to the site covered with climax vegetation, is the field where the underlying principles that determine sound silvicultural practice must be discovered." Throughout the book, in discussing fundamental biological problems, Toumey never for a moment loses sight of the practical considerations and the ultimate purpose of all this research, which is the production of the most desirable crop of timber possible under any given set of conditions.

Part I, The Site Factors, which contained 171 mimeographed pages, has been expanded to 250 printed pages with 11 text figures. The first chapter, "Definitions and Generalities," shows the importance in silviculture of knowing the site factors, and gives the broad divisions under which these factors may be considered. Three chapters (of 12, 32, and 17 pages respectively) are devoted to the climatic factors: temperature, solar radiation (light), water, wind, lightning, and atmospheric impurities. Light (chapter III) receives the major share of attention, and the author shows that plants will thrive in but a small fraction of full sunlight. The reasoning and experimental proof are convincing, but do not demonstrate that the plant will grow as fast as in full light. Three chapters (of 52,

37, and 21 pages) are devoted to physiographic factors, one each to soil, soil moisture, and soil temperature. The biotic factors receive one short chapter (18 pages), and two chapters (of 34 and 15 pages) are devoted to a discussion of the reaction of forest vegetation on the site factors. The two latter chapters include not only the influence of the forest on temperature, moisture, rainfall, erosion, and so forth, but its influence on man, and close with a brief but effective statement on forest aesthetics. The inclusion of a topic so little considered by the average American forester as forest aesthetics illustrates not only the comprehensive scope which Toumey covers, but his far-sightedness in recognizing the growing importance of this aspect of forestry. The director of the Swiss Forest Experiment Station, Professor Henri Badoux, last summer told the reviewer that he strongly emphasizes this topic, and gives a special course on it.

Part II, The Forest, has not been expanded as much as Part I (173 printed, 143 mimeographed pages) and has not been illustrated. The first chapter (44 pages) deals with the classification of vegetation, and discusses the various conceptions and purposes of forest types. The second (35 pages), on the origin and development of forest communities, deals with succession. In both these chapters the author has made his meaning clear without using the specialized ecological terminology which would not have been understood by most foresters or even by many plant ecologists.

In his section on the direction of succession (pp. 320-321) he follows Clements and others in denying the possibility of retrogressive succession. Interference which sets back the succession is, of course, not regression. It seems to the reviewer that Cooper[1] has presented a clear case of retrogressive succession due to natural causes, and unanswerable arguments[2] for recognizing this type of succession.

The next two chapters (of 37 and 26 pages) deal with the stand. Here the relative advantages of even-aged and uneven-aged stands are considered, and a good deal of attention is paid the question of composition in relation to pure and mixed stands. Reproduction under various methods of cutting is discussed, together with the effect of fire, lumbering, and grazing on natural reproduction. The last chapter (37 pages) takes up the individual tree, covering specific and racial differences, tree form, growth in its various aspects, and reproduction.

The treatment of soil moisture is perhaps the outstanding feature of the book. The section on the water supply of forest soils, pages 142-146, is especially recommended to anyone who has been confused by the complexity of the physicists' formulae and disagreement of authorities. Available and unavailable water in relation to the wilting coefficient are explained in simple terms. The conclusion reached, that unavailable water (the amount below the wilting coefficient), is a question of *rate of water movement in the soil* rather than of quantity, is in accordance with the latest conceptions on on the subject.

The author's own experiments (trenching plots) have shown the importance of

[1] Cooper, William S. 1926. Vegetational development upon alluvial fans in the vicinity of Palo Alto, California. Ecology, 7: 1-30.

[2] Cooper, William S. 1926. The fundamentals of vegetational change. Ecology, 7: 391-413.

root competition in reducing soil moisture under the forest, and the effect which this has in preventing the establishment of reproduction or of under-vegetation. Yet the discussion of the relative importance of light and moisture is eminently fair. Throughout the book wherever the question of soil moisture enters, the drain caused by root competition is emphasized. But only once does he go further than a judicious consideration of observed facts would seem to warrant. That is on page 356 (end of Section 30) where he says "The uneven distribution of reproduction in a stand is due more to the openings in the root complex than to the openings in the canopy." Everyone knows that reproduction comes up under holes in the canopy. The canopy holes may coincide with holes in the root complex, but the reviewer's experiments, in which root competition was eliminated, showed a much more rapid growth in the openings than under the canopy.[3]

In his discusion of podsol soil, Toumey distinguishes between regions where podsol is the normal condition due to climate, and regions where "brown earth" is normal and podsol may be caused by silvicultural treatment. He recognizes the important fact, which some foresters dispute, that special soil conditions may produce a "mull" humus in a climate wherein podsol is the normal soil.

The forester's weapon against soil deterioration is, Toumey says (p. 124), the retention of beech and other hardwoods in mixture with conifers. The reputation of beech as a soil improver is based on the European species, and has been accepted in America without question. Hesselman, in his visit to the United States in 1927, observed that the leaves of our beech are not nearly as favorable as those of the European beech, or as those of several of our own hardwoods such as maple and birch. An investigation of the relative value in humus formation of the leaves of our different northeastern hardwoods has recently been made by Melin, and will shortly be published.

It would be unreasonable to expect that a book of such scope should be without defects. The author himself is the first to recognize this danger and has endeavored to guard against it by the prepublication of mimeograph copies. In the main he has been remarkably successful. Perhaps his most conspicuous omission is the absence of citations from Waksman's classic work on Soil Microorganisms.[4] Toumey's book was written before Waksman's came out, and it is possible that the revision of the section on forest humus (in chapter V) was also completed before Waksman's work was available. On the whole, Toumey has covered soils and forest humus adequately, but has made one rather bad mistake which Waksman's book would have spared him. This is in the second paragraph on page 104, where he says: "The so-called mold fungi and both aerobic and anaerobic bacteria break down the cellulose in the litter." This is correct, but then he continues: "In addition, however, their excess energy appears to be expended in absorbing nitrogen from

[3] Moore, Barrington. 1926. Influence of certain soil and light conditions on the establishment of reproduction in northeastern conifers. Ecology, 7: 191-220.

[4] Waksman, Selman A. 1927. Principles of soil microbiology. Baltimore, Williams & Wilkins Company. Pp. xxviii + 897, 19 pl., 82 figs.

the air; thus active moldering is accompanied by the addition of nitrogen to the soil." Waksman states (*loc. cit.*, p. 105), "Algae, fungi, and actinomyces do not fix any atmospheric nitrogen."

The chapter dealing mainly with forest influences (IX, pp. 203-233) is adequate and conservative. The section on "The Effect of Forest Vegetation on Surface Runoff" (pp. 225-228) gives about all that the student needs to know, but one wonders why no reference is made to the Wagon Wheel Gap experiment of the Forest Service.[5] Nor is there any reference to the Swiss experiments on streamflow.[6]

In his discussion of uneven-aged stands Toumey states (p. 377) that red spruce which has remained "under oppression for many years, when released lives longer and continues at a better rate of growth than trees that have never been oppressed. Hemlock and white pine . . . . exhibit the same reactions and make high grade lumber." There is involved here a very important biological phenomenon, which is at present but little understood. The reviewer ventures the opinion that knowledge of the causes of this phenomenon, when once acquired, will have a far reaching effect in silviculture.

There are a few minor slips which would hardly be worth mentioning if they did not stand out on account of the general excellence of the book. On page 32, no publisher or place is given in the reference to Spoehr's Photosynthesis. On page 38, in footnote 2, the American Journal of Botany is cited as simply "Jour. Bot." On pages 36 and 48 the title of Garner and Allard's very important work on the photoperiod is cited as "Sunlight and plant growth" instead of as "Effect of relative length of day and night and other factors of the environment on growth and reproduction in plants." The change of temperature with a rise of 300 feet in altitude is given at 1° C. on page 175, and as 1° F. on page 303. The latter is of course correct.

The book brings together for the first time the results of investigations in allied fields which have a bearing on silviculture, and makes these results intelligible and available not only to research foresters but to the entire profession. Anyone who has tried to keep even moderately in touch with these various investigations realizes the vastness of the work which Toumey undertook. There was not only the finding of the results in the widely scattered literature, but their interpretation, and the reconciling of conflicting viewpoints. He has synthesized this vast material and given us the result in a work which places foresters in this and other countries forever in his debt. It is safe to say that the book will serve as the foundation for the development of a silviculture adapted to Ameri-

[5] Bates, C. G., and Henry, A. J. 1921. Streamflow at Wagon Wheel Gap, Colorado. Mon. Weath. Rev., 49: 637-650. The complete report on the project was not available till the summer of 1928 as "Forest and streamflow experiment at Wagon Wheel Gap, Colorado. Final report, on completion of the second phase of the experiment." 1928. Mon. Weath. Rev., Supplement No. 30, pp. iv + 79. But the 1921 article above cited, which constitutes a summary of the results at that date, was published in time for inclusion.

[6] Engler, Arnold. Experiments showing the effect of forests on the height of streams. Mitteilungen der Schweizerischen Centralanstalt für das Forstliche Versuchswesen. Zürich, XII, 1919.

can conditions, and will exert a profound influence on the whole future course of forestry in America.

BARRINGTON MOORE.

All foresters in America, we believe, will welcome a text-book of silviculture with a domestic "tang" to it, in which the principles are interpreted in terms of American forests and forest problems. Particularly will Professor Toumey's new volume be welcomed by those with a scientific turn of mind, who have hoped that the fundamentals rather than the empiric *art* of silviculture might be treated, and that we might have in a single volume all of the approaches to the science of tree growth embodied in previous silvicultures, plant geographies, physiographies, and the less comprehensive treaties of ecology and plant physiology.

The present work is, therefore, somewhat monumental in its scope, and it is unreasonable to expect that any single individual could treat the various angles of the subject with uniform understanding, thoroughness, and appreciation. While the book contains no glaring defects of the sort implied by the above remark, a critical review must mention a number of minor points which suggest that the author has gone beyond his "depth." Such defects are perhaps not important from the pedagogical standpoint, since the undergraduate student is indeed fortunate if he leaves a subject of this sort with *some kind* of an understanding of its various aspects. They do, however, place the book in the text-book category, rather than that of the reference book for the student who wishes the most up-to-date and thoroughly scientific treatment of all or any of the sub-divisions of the subject. This weakness is emphasized by the failure of the author to accomplish much sifting of the source materials.

Considered from its broad outlines the book is very promising. Part I takes up the site factors. Under climatic factors, temperatures, solar radiation, precipitation and atmospheric moisture, wind, lightning, and atmospheric gases are discussed. Under the main heading, Physiographic Factors, which the author uses in lieu of the "edaphic factors" of most modern ecologists, soil composition, soil moisture and temperature, and the effects of altitude, slope, exposure, etc., are treated. Chapter VIII deals with the Biotic Factors, under which are considered Competition, "Culturalism," "Mutualism," "Communism," and Flora and Fauna of the soil. The introduction of these unfamiliar names is to be regretted. The last two chapters of Part I deal with the action of the forest upon the site factors, including not only the direct effect of forests on soil and atmospheric conditions, but the indirect effects which are usually treated under "Influences," that is, the effects on run-off, erosion, etc., and the effects of windbreaks. Even the human values of forests are not neglected in Chapter X.

Part II deals with The Forest. Chapter XI covers forest vegetational units, including the usual discussion of forest types and the various meanings of that term. Chapter XII is primarily a discussion of succession, and from the standpoint of the possible treatment of some American problems, we consider it one of the most important chapters of the entire book. However, the treatment by Toumey is by no means clear, concise, or

convincing, and the critical student interested in gleaning specific facts will find himself reading Clements' work to learn about forest problems.

Chapters XIII and XIV deal with the Stand, in terminology more familiar to foresters, the first having to do with stand composition in its various aspects, the second with natural reproduction and with growth. The last chapter is devoted to a discussion of the individual tree. Inasmuch as this is the mechanical tree of mensuration studies, rather than the physiological tree which we need to know to understand the main themes of the book, it is not so difficult to understand why this discussion has been placed at the end, rather than the beginning of the book.

The most serious criticism of the book that can be made is that it is poorly written. It undoubtedly occupies twice as many pages as are needed clearly to present the subject matter. While the reviewer is without experience in teaching, he believes that even in the writing of text-books simplicity and directness of expression are evidences of clear thinking and are the more likely to lead to clear thinking on the part of the student. Although some repetition of thoughts is often desirable for emphasis, multiplication of words merely beclouds the true meaning. A single striking example will suffice (page 296):

> Whenever the various elements in the vegetation so react upon each other and on the site that the character of the vegetation as to growth-forms changes, through the driving out of certain elements and the invasion of others, the vegetation moves forward from one stage to another in the succession. This moving forward follows a series of invasions by other growth-forms on the same site; however, all invasions do not result in bringing about a stage in succession. The number must be large enough to sufficiently modify or control the vegetation so as to cause a more or less marked decrease in the original occupants of the plant community. Succession is universal in community development. The various stages occur over and over again in the development of every climax forest.

This entire paragraph is stated in the first and last two sentences, of which the last is misleading, since a forest of considerable extent may move directly from the first to the final stage without any set-backs whatever. Just what Professor Toumey had in mind here, we can not guess.

While we cannot attempt to criticize every part of the discussion, we need look over only a few pages to observe numerous specific points bearing out our contention that Professor Toumey's writing will not stand a searching light. Some of these items, insignificant in themselves, yet serve to brand the book as being far from exact and scientific.

In the Introduction, on page xxv, the author makes the statement, "In the maintenance of soil quality the natural forest is the ideal, although it is deficient in revenue." While it is true that naturally regenerated forests are coming more and more into favor (where other systems have long been used) because they do not give the opportunity for soil deterioration, the examples are too frequent in which wholly undisturbed forests create bad soil conditions, to permit the above generalization. This is the case not only in northern forests where natural stands create acid and "raw humus" sufficient to prohibit their own reproduction, but also of pure stands in general, which often do not have as

good soil conditions as those in which mixtures are artificially encouraged.

An example of uncritical use of reference data is found on page 6, where the reviewer's opinions are cited as "emphasizing" the utility of height as an indicator of site quality. In the article referred to, the reviewer summarized his discussion with this sentence, "It (height) does not sum up all the qualities which the forester is interested in, and which he attempts to express in the term 'site quality.'"

A mis-use of data of a somewhat different order may also be cited from page 38, where the earlier of two papers is quoted without any explanation whatever of obvious discrepancies in the results, adequately explained in the text of the paper, and again referred to in the later paper, also quoted. Under the circumstances, the use of the early results when later and better ones were available is, to say the least, a mis-use of printer's ink. The reviewer mentions these two instances of his own work merely because he is familiar with the facts.

The chapter on Solar Radiation is an example of the unnecessary complexity of the treatment, the failure clearly to state the case for any one factor. In the first place, while solar radiation *per se* is clearly defined, the author fails to state the case for the plant; what is the function of solar radiation, the nature of photosynthesis? Assuming that the reader or student had not been trained in plant physiology, the nine lines on page 32 which attempt to define the action of light on the plant, would not go very far toward clarifying the subject. Toumey says: "The physiological significance of this process (photosynthesis) lies in the fact that it involves a transformation of the radiant energy from the sun into chemical energy." Is this the main significance, and if so, just what does "chemical energy" mean to the less-than-thoroughly trained physiologist? We had always thought that the main significance lay in the fact that the carbohydrates were formed, and therefrom the entire structure of the plant built up.

But this is not the main criticism: every statement regarding the effect of different intensities and qualities of light must be qualified by reference to the other factors which modify that effect. This halting procedure may be the way to develop conservatism in prospective ecologists and physiologists, but is it the way to give the student a clear conception of *how light operates on the plant?* This should be an object in itself. To our mind, the entire discussion of modifying factors should have been disposed of in one or two paragraphs at the close of the chapter.

In the last paragraph of page 18, under the discussion of temperature effects, "extremes of temperature" are referred to, where obviously only low temperatures are involved. The resistance of plant tissues to high temperatures is quite probably affected in the opposite direction by high sap concentration or low water content.

Again, in the discussion of the absorption of heat by the tree, page 19, the reviewer finds occasion to disagree, at least with the mode of expression. "Most of the heat that comes to the tree is directly absorbed from its environment through conduction." Admitting, as anyone must, that all of the heat available to or in the tree comes directly or indirectly from sunlight (even "the internal

heat generated by the life processes"), and that the greater part is undoubtedly absorbed directly by the leaves, to the interior of which it is transmitted as *light* and not largely as *heat,* we fail to see the significance of the conduction process. Even the stem of the tree is warmed at its surface by direct radiation probably more than it is ever warmed by conduction from an atmosphere warmer than itself; after the surface warming, conduction of course plays its part. Finally, the suggestion that the roots and lower portion of the bole are warmed through the soil water and the movement of the transpiration stream, seems to us entirely unwarranted, considering that the layers of the soil from which most of the water is drawn are, at least during the growing season, generally cooler than the atmosphere above or the stem of the tree. One cannot avoid the conclusion that Professor Toumey has attached altogether too much significance to the warmth of the surface layer of the soil during the time when it is being insolated.

While this is largely a matter of terms, we wish to point out that at the outset of the book, that is in the preface and introduction, the idea of the "plant community" is considerably stressed, although elsewhere in the text, except in Chapter XII, the treatment is not that of communal (common) activities and interests, but that of the individual tree against all other trees and against the physical factors of the universe. We would suggest to the author that the name "plant gang" would be more appropriate, since the association of trees preys constantly on the weaker members of plant society, and the individuals upon each other when the occasion demands. It is not sufficient that, together, trees react upon their environment and thereby upon each other. One band of savages may readily react upon the environment of another band, yet the relations between the two are not "communal" and hardly "social" in the strict meanings of these words. The young are not nurtured or cared for, but must fight for their existence from the beginning. Moreover, a tree group of a given species is often actually working for the reproduction of another species. Intelligent socialism! More important than the use of such words is it to realize that, in the sort of studies that silvical progress calls for, even the environmental factors of a single limited locality cannot be considered uniform; rather is the environment of every tree seedling slightly different from that of any of its neighbors. It is this difference which produces difference in development between individuals, and introduces more than one species into the same site. In the light of these facts, and of the actual treatment afforded the different physical factors in the discussion, it is pure faddism to mention the "plant community" as though it were something possessing unity of purpose.

Despite the many minor flaws which one might pick up in this way, and which surely are not matters of opinion, the book will probably prove suggestive to many beginners in the field of what may be called "forest ecology" and which is certainly a most interesting and significant field. As Professor Toumey says "The more profound the forester's knowledge of the life of the forest in all its aspects, the less the difficulties he encounters in the modern practice of silviculture."

C. G. BATES.

The Development of Governmental Forest Control in the United States. By Jenks Cameron. *Publication of the Institute for Government Research: Studies in Administration. The Johns Hopkins Press. Baltimore, Md., 1928. Pp. 480. $3.00.*

It has for years been the hope of American foresters that some day there would appear one able to tell in worthy manner the story of the development of forestry in the United States. In Mr. Cameron's book one finds much of that story, in so far as it relates to the Federal Government, well and vividly told. But this book is much more than a narrative of what has been accomplished in forestry. Its essential purpose is to trace the influence of the forest in shaping the economic and social conditions that have worked to make our nation what it is today. It is not undue praise to say that this book is a real contribution to an understanding of why and how the Spirit of America came to be.

Starting in the earliest years of the Colonial Era, the author portrays the intimate part played by the forest in the lives and fortunes of the colonist, the pioneer, the settler, and the folk of the steadily westering frontier down literally to the present day. The narrative begins with the arrival in 1631, of the "Pied Cowe" at Berwick, N. H.—a ship that brought from London the model for a sawmill there. It closes with the signing of the McSweeney Forest Research Act of 1928. Mr. Cameron has limned his canvas with bold and telling strokes. He writes in a compelling style that makes one loath to lay the book aside until every chapter has been read.

The story is of the conflict between Adventure and Order; the frontier versus the settlements. It traces the slow change in point of view regarding the forest from the attitude of the pioneer, eager to conquer the wilderness, impatient of restraint, holding nothing impossible, to the orderly and forward looking procedures that today we group under the term "forest management." Were the book to have a sub-title, it might run "The Rise and Fall of the Legend of Inexhaustibility." The dominant theme of the book as it outlines the march of this movement through three centuries is that "the forest is a thing fundamental, a part of the very warp and woof of everything that America has come to be."

Although not so divided by the author, the twelve chapters fall logically into four divisions. The first seven deal with the long period during which the virgin forest was giving way before the advance of the pioneer, its products going to help create the conditions of settled society that followed that advance. The second division, chapters 8 to 10, comprehensively but briefly tells of the organization of the National Forests and the administrative development of the Forest Service. Chapter 11 is a clear exposition of the period of forest controversy after the World War that culminated in the passage of the Clarke-McNary Act in 1924, a law that "gives the nation at last the real beginning of a genuine forest policy." The final chapter, "The Forest and American History," recapitulates in brief summary the outstanding events and reemphasizes the note that out of the forest came the might of America, the will for independence, and perhaps more than all, "the irreverence for the

impossible" that, tempered and hardened, became in time the true spirit of America.

The text is prefaced by a short introduction by Dr. W. F. Willoughby, Director of the Institute for Government Research, and is followed by a useful bibliography of 26 pages, compiled by Sophy H. Powell. Although the text is replete with citations, footnotes, and other evidences of good literary workmanship, the author's virile style and pungent comments on the events he is describing make the closely packed pages eminently readable.

For those to whom Mr. Cameron's name is unfamiliar, it may be said that he is a graduate of Johns Hopkins University, who has lived for many years on the Pacific Coast, engaged in newspaper and legal work. Since the war he has been connected with the Institute for Government Research in the preparation of monographs dealing with varied activities of the Federal Government.

Concerning his main thesis, the present reviewer has no quarrel to pick with the author. On the contrary it seems to him that while the general idea may not be new, Mr. Cameron has so marshalled his facts as fully to justify the conclusions he reaches. As an element in the development of the American point of view the forest has played a part not to be overlooked by any later historian. By the same token this book has value for any one who would undersand that viewpoint in its relation to the forest, whether as exemplified by Paul Bunyan on the one side, or by Theodore Roosevelt on the other.

With another of the author's conclusions there may be less accord. He holds, viewing the matter broadly, that the benefits that have come from even the unrestrained exploitation of the forest have in the physical upbuilding of the Commonwealth gone far to offset the waste, the skulduggery, and the other manifest evils that attended it. Mr. Cameron does not gloss over the dark side of the picture; but he also stresses its other aspects.

"The American people squandered their patrimony. The American people are alone to blame. But at that did they not come pretty close to getting value received? . . . . Measured by the dollar yardstick does the billion or so in timber that has been wasted or stolen begin to compare with the tens of billions of solid values represented by the empire that the spirit of the Borderers has made an accomplished fact since 1850? And is not the very spirit of the borders a resource worth an infinitude more to America than all the material resources it has unquestionably squandered?" (page 116) . . . . "The Atlantic forest fitted the Anglo-Saxon to brave and conquer the forests of the west. The forest of the west made him into the American."

The real significance of Mr. Cameron's book is that it analyzes critically the reasons behind the causes, economic, political, and social, that have led the national viewpoint to change with the passing of the years and the discovery that spots of bare floor were appearing in the bin of Inexhaustibility.

In the limits of a review it is impracticable to summarize in detail a book so full of dramatic happenings. Comment must be limited to a few salient features. First, the significance of the King's Broad Arrow placed on the white pines of New England in the eighteenth century. Timber as well as tea entered into the grievances of the colonists and had its part in bringing on the Revolution.

Early in the life of the young republic came forest problems. The needs of the navy led to the Live Oak Timber Reserves in the south, set apart in 1799 and 1817. A little later came the first attempt at forestry practice in the proposed plantations of live oak at Santa Rosa, Florida. Launched under the fostering care of President John Quincy Adams in 1825, this venture came to disaster in the turbid and tempestuous political waters of the succeeding administrations. The efforts to protect the live oak forests against spoliation met with little better success. As in the preceding century there were still " borderers on the Dismal who make free with the King's land without the least ceremony."

But out of this period did come one tangible contribution to order, the Trespass Act of 1831. For sixty years this was the only significant law on the Federal Statute books dealing with depredations on public timber. It is the basis for the present Timber Trespass Section of the Revised Statutes. While interesting as a narrative the exhaustive treatment accorded this period seems somewhat disproportionate. It is defended by the author in this statement: " It was upon this tithe (of the government owned forests) alone that practically the whole forest activity of the government was concentrated during its first half century. . . . . The results of that groping were in after years to affect the forests of America as a whole."

The decades from 1850 to 1880 (chapters 5 to 7) were marked by the looting of the public forests on a grand scale. There was no law by which government timber could legally be acquired by purchase although the demand for timber increased each year with the growth of the nation. Naturally there were plenty ready " to profit by the occasion." This held true for the south, the Lake States, and later the west coast. Sporadic attempts of certain officials to enforce the law usually ended in an order from Washington calling off any such drastic action. Was not the forest inexhaustible? Was there not crying need for timber? Why bother about trespass, especially if those accused of theft and spoliation could summon political influence?

But much as a top sergeant saves the face of authority, when he bawls at his company, " Let me ketch you at this . . . . ," and then looks the other way, so for around twenty years the Law Officer Circular of 1855 forbade any compromise with offenders, while in practice a system grew up, based on payments compromising theft of timber, that backhandedly amounted almost to an authorized sale of government stumpage. From a variety of sources that give evidence of painstaking research, are brought together many incidents of this period that lose nothing of their dramatic flavor in the telling. But whether payment for it was made or not the timber went to the upbuilding of more and more new states.

There were, however, a few cases where law enforcement was really carried out. Perhaps the most picturesque incident was when the Federal Deputy Isaac Willard, at Manistee, Michigan, in 1854, rounded up a bunch of timber thieves under the guns and with the aid of the blue jackets from a naval vessel, the U. S. S. Michigan. This tale, with many others, makes Mr. Cameron's book interesting reading.

Slowly, in the seventies, the realization began to make headway that perhaps after all the Legend of Inexhaustibility might not be wholly true. Then appeared a Secretary of the Interior, Carl Schurz (1877-1881), who demonstrated that the old trespass law of 1831, as amplified in 1859, actually did have teeth. Times were changing. The Broad Arrow had returned and had come to stay. The reason? "Because the development of the country had reached a point where it was a necessity."

Only passing mention is made by Mr. Cameron of the Timber and Stone Act and the other similar laws of the late seventies, through which so much timber land passed from the Government into private ownership, although in a footnote attention is called to the résumé of the working of these laws in the Conservation Commission Report of 1909. Rather does the author concentrate his attention on the stealings of earlier decades.

Chapter 8, under the caption "Governmental Recognition," traces the rise of the new point of view in forest thought. Concise but adequate treatment is accorded such features of major interest as the wave of tree planting enthusiasm in the seventies; the appointment of Dr. Hough as special agent for Forestry in the Centennial year, and the work done by him and Dr. Egleston; and the activities of the American Association for the Advancement of Science and of the American Forestry Association that led up to subsequent legislation, more especially the basic acts authorizing the forest reserves in 1891 and providing for their administration in 1897.

To Dr. B. E. Fernow, Mr. Cameron pays high tribute. These words, which follow an enumeration of his activities, may be quoted: "Dr. Fernow was not only the true pioneer of American Forestry but the man who established it on a firm and enduring foundation by hard work and sane work during its critical years. He planted the tree and tended it till it had taken vigorous root. Those who came after him have only had to watch it grow."

The years of the Pinchot administration, 1898-1910, are the subject of Chapter 9. Especially to be commended is the elucidation of the perplexingly muddled administrative situation that obtained from 1897 to 1905, and the making clear of the real significance of the Transfer Act of 1905. There is also a good exposition of the Indian Forest land problem, with particular reference to the Chippewa and Menominee Reservations, and an interesting account of the Oregon and California land grant case. "Things it (the railroad) might have got away with in the sixties, possibly even in the eighties, in the early nineteen hundreds had become well known as the wallow mark of the great red dragon and the spoor of the octopus. And for those creatures there was now no closed season among gentlemen eager to profit by the occasion under the new rules."

A sympathetic explanation is given why the early predictions as to large revenues from the National Forests were not verified. Indeed a number of points are cleared up, such as the relation to one another of certain laws and administrative acts which at the time was not always clear even to some of those in the Forest Service. And this note: "For the Forest Products Laboratory idea's fruition Mr. Pinchot deserves and should be given great credit. The conception

was not exclusively his, but it was his work that put it in the way of becoming a reality instead of a dream."

The surprising thing about this chapter is its omissions. One looks in vain for any reference whatsoever to the coming to a head of the Conservation Movement, or to the events that led out therefrom. Surely the happenings of those years are as worthy of record and comment as are the detailed treatment of the incidents of the live oak controversy in 1830. Or must the historian wait longer than two decades? The chapter closes with this paragraph:

"Into the rights and wrongs of the historic controversy of which this explosion (Mr. Pinchot's removal) was but one of the minor sputterings, we do not propose to penetrate. We have already, of necessity, wandered here and there about its purlieus, warily avoiding its heavily mined areas and side-stepping its controversial pitfalls. The reader desiring more searching exploration will have to organize his own pack train."

Chapter 10, "The World War and After," is a thorough-going and appreciative enumeration of the recent and present activities of the Forest Service. Mined areas are again avoided, except for one rather sharp criticism of the policy that reserved large areas of the National Forests for administrative sites in 1908 and 1909, and of the attitude then taken by the Forester regarding the water power corporations (pp. 301-303).

For the most part it is a narrative of the busy years that saw, among other things, the Forest Products Laboratory and the Experiment Stations organized and at work; the Week's Law enacted (note being made of the objections raised by General Chittenden); the reorganization of the legal work in the Forest Service after 1910; the Water Power Act of 1920; the systematic handling of the forest fire problem; the legislation in regard to forest roads; the grazing controversy of 1924 and 1925; and the rounding out of the timber sales policy of today. This chapter will prove of value to those who wish a picture of what the Forest Service now is and how it works.

The chapter entitled "The Movement for a National Forest Policy," is a clear cut account of the controversy that held the stage from 1920 to 1924 over the question of how the forest industries ought to be conducted; "the question as to how a nation of inordinate wood users was going to adjust its wood-dependent industries to a woodless, or near woodless, condition."

The ideas of the protagonists of the several main positions in this debate are made clear by copious quotations, made under a thin disguise of sobriquets that are not intended really to conceal the identity of the men in question. There are also digests of the several bills introduced in Congress in furtherance of these various ideas.

The sympathies of the author are frankly with those who held that "should" rather than "must" was the method of approach to strive for; cooperation in place of compulsion. Consequently the outcome, the Clarke-McNary Act of 1924, is hailed as being a most important milestone on the road toward a genuine forest policy.

The story ends with the optimistic note that this act, like all that had gone before, is but the logical development of

the slow "working toward order" that, with all its setbacks, has been going on even from colonial days.

RALPH S. HOSMER.

The New Exploration—A Philosophy of Regional Planning. By Benton MacKaye. *Pp. 235, with maps. Harcourt, Brace & Company, 1928.*

It may seem a far cry from "The New Exploration" to conservation, yet the book by Benton MacKaye is one of the most notable contributions to the philosophy of conservation that has appeared within recent years. Of course it depends on what one's understanding of conservation is. To one whose vision of conservation is limited by the "bag limit," "one-buck law," barbed or barbless fishing hooks, and similar problems, "The New Exploration" will not tell a thing. To one with whom conservation does not stop with protection of game, fish, or timber, but embraces an orderly and planwise relation of man to his entire environment, both physical and social, the book opens vistas of unlimited possibilities, images of great splendor, and fresh stimulating impulses for human action.

Benton MacKaye finds that our glorified civilization not only has "messed up" things in the use of our natural resources, but also produced a social jungle, "a wilderness of civilization," not unlike the jungle of the beast. MacKaye does not moralize on the evils of our modern civilization. He does not preach the gospel of returning "back to nature." He accepts the mechanical progress of our times, but he wants these mechanical inventions to serve the community instead of enslaving it. The trouble, as MacKaye sees it, is that our industrial and social development was a planless process. The same old story of which foresters have concrete evidence almost every day! Man enters a region of virgin timber. The timber has a commercial value and is needed. The forest is destroyed without thought of the consequence to the future of the community. What is true of the forest is also true of many other human necessities—living conditions, cultures indigenous to the country side, beauty of the surroundings, and harmonious relation between field and factory. Man simply takes from his environment to satisfy his immediate needs with little thought of the social and economic consequences.

This hit-or-miss, haphazard, planless development, MacKaye, with the methodical mind of an engineer, would replace by an intelligent, orderly, and planwise development. The philosophy of regional planning which Benton MacKaye develops is, in the parlance of foresters, nothing else but a *working plan,* a *plan of management* applied not merely to a comparatively small forest property, but to entire communities, to entire regions, and embraces natural resources as well as the flow of commodities and the development of the environment. It is, in short, the gospel of conservation expanded to embrace the entire life of the community or region.

MacKaye's career as a forester was not in vain. Out of the germ of *forest working plans* there emerged a bigger concept of social working plans. The many examples and illustrations scattered throughout the book bear testimony to this influence. The most telling concrete

illustrations are those borrowed from the organization and administration of the National Forests. The harmonious development of the forested slopes of the mountains, the pasture and agricultural land of the valley, the water power inherent in the mountain streams, the recreational possibilities of the mountain range as conceived in any forest working plan, MacKaye applies to the life of a community and expresses in terms of human happiness and cultural development. The principle is the same, but it is applied on a larger scale. It is the humanization of the philosophy of conservation as applied to community life.

Regional planning, as conceived by MacKaye, will change bare existence into "true living," mechanization into culture, and metropolises "ever sprawling farther and farther to the disadvantage of all its inhabitants" into regional cities. It is a plan for a social organization in which human life is brought into harmonious relation with its environment.

The theme is developed with gripping vividness, with a wealth of parallels, images, and facts gathered from nearly every part of the world and every part of human life, and is written with a simplicity and clearness of style approaching that of Thoreau.

The distant horizons that "The New Exploration" opens, the alluring pictures of a *world regained,* are marred only by one sad reflection—how can this ideal state be attained? When we talk of regional planning in terms of landscapes, laying out state forests and municipal parks, the task is comparatively simple and clear, but when it comes to reshaping radically the economic life of such cities as Boston or New York afflicted with elephantiasis, the task seems almost insurmountable. Galileo once said: "If geometric axioms affected human pockets, even they would be disputed." The regional planning which MacKaye proposes will affect many human pockets and no matter how sound and convincing the plan itself may be, it will be resisted. It is, after all, easier to deal with inanimate things like trees than with human beings. As long as the present order of things *pays,* the finest plans are likely to prove merely dreams and be shattered against the rock of indifference, ignorance, and human selfishness. Much as we may think, we are not yet the captains of our fate and it is still a long and uphill struggle to realize the plans of which Benton MacKaye speaks with such sincerity, conviction, and sound backing of common sense.

RAPHAEL ZON.

Forest and Stream-Flow Experiment at Wagon Wheel Gap, Colorado. Final report on completion of the second phase of the experiment. By C. G. Bates, Silviculturist, Forest Service, and A. J. Henry, Meteorologist, Weather Bureau. *Monthly Weather Review, Supplement No. 30, U. S. Department of Agriculture, Weather Bureau,* 1928. Pp. 79.

Thorough-going reviews of current literature are an infallible sign of a healthy professional spirit. They show the interest which members of the profession take in the progress within their professional field. Measured by this standard, I am afraid our professional

spirit is at low ebb. It seems that every one of us is more eager to write himself than to read what the other man has already written. Possibly, if we were reading each other's writing, there would be less need for every one of us to write. Think of the conservation in paper, printing ink, and labor!

These thoughts came to me as I watched the reception given the work by Carlos G. Bates and A. J. Henry, on the relation of forests to streamflow. Here is a piece of work which extended over a period of more than 15 years. It involved an expenditure of about $150,000. It touches upon one of the most fundamental problems in forestry. It appeared nearly six months ago. Yet there was barely a reaction on the part of the profession to the results published. One need not accept all the conclusions of the authors, and yet be tremendously impressed with the stupendousness of such a piece of research, patiently carried through long years under many handicaps and with no precedents to fall back upon as to the technique and methods of approach. One cannot help admiring the thorough-going manner in which the data were collected and the painstaking labor involved in working them up.

The story of the experiment is probably known to many foresters.

It was inspired by a study of the relation of forest cover to streamflow conducted by the Swiss Forest Experiment Station on two small watersheds in the Swiss Alps in the valley of the River Emme.

Two mountain watersheds of about 200 acres each, located on the drainage area of the Rio Grande in southern Colorado, were selected in 1910 for the experiment. Their elevations are between 9000 and 11,000 feet. The principal object was to determine, quantitatively, the protective value of forests in mountainous regions in binding the soil, preventing erosion, and modifying streamflow.

Because the plan of study called for the services of men skilled in meteorological observations as well as the use of considerable instrumental equipment, the cooperation of the Weather Bureau was secured for this experiment. Although the active work of getting material and equipment on the ground was begun by the Forest Service and the Weather Bureau on June 1, 1910, the first meteorological observations did not begin until October 22, 1910. After eight years of continuous streamflow measurements and nearly nine years of meteorological observations, one of the watersheds was denuded in 1919, and the other was left untouched during the remainder of the experiment. The records of streamflow and of meteorological factors cover, therefore, more than eight years before denuding and seven years after denuding.

The two watersheds for the entire period are comparable in every respect except as to the forest cover. They were as similar in area, topography, geological formation, soil, and forest cover as two watersheds could be found in nature. The total area of one watershed was 222.5 acres, while that of the other, subsequently denuded, was 200.4 acres—a rather insignificant difference. A difference of greater importance was that one of the watersheds was considerably longer and narrower than the other, and that a small portion of it rose to an elevation of about 400 feet higher than any part of the other watershed. The geological

formation of the two watersheds was uniform as to structure and soil. The forest cover on both watersheds was light and open, made up largely of aspen which followed the original Douglas fir stand after a burn in 1885. In the fall of 1919 one of the watersheds was cut over, but almost immediately after the cutting and burning of the slash a thin cover of aspen root suckers augmented by a fair cover of grass took the place of the older aspen stand.

Dams were built in the lower portions of the two streams and equipped with stream-measuring devices. Settling basins for measuring silt were also constructed. The two watersheds were covered with six primary meteorological stations, at which the air temperature, relative humidity, wind movement, precipitation, snowfall, soil moisture, and evaporation were measured.

The mean annual temperature before denudation was about 34° F., the mean annual precipitation about 21 inches. Precipitation was about half snow and half rain, mostly of a light character. The run-off in years when the precipitation was sufficient and snow melting conditions were favorable formed as much as 42 per cent of the current year's precipitation. In years of low precipitation and unfavorable climatic conditions, the run-off constituted as little as 17 per cent of the precipitation. The soil was deep, coarse sand not subject to erosion and capable of storing large quantities of water. After one of the watersheds was denuded, certain changes were observed both in the climatic factors and in the discharge of the streams.

The annual mean temperature of the denuded watershed increased by 1.3° F.; the mean annual maximum temperature by 2.1° F.; and mean annual minimum temperature by 0.7° F.

The wind velocity on the denuded watershed showed an increase of about 260 per cent.

Snow melting, as a result of denudation, was advanced by 4 days.

The mean relative humidity decreased.

The average run-off of the watershed before denudation was 6.18 inches. After denudation it increased to 7.26 inches, while the watershed that was not denuded increased only from 6.08 inches to 6.20 inches. The denuded watershed showed, therefore, an excess flow of about 0.96 inches for the average of 7 years after denudation.

The crest of the floods on the denuded watershed was advanced only about 3 days.

The height of the crests of the denuded watershed increased over that of the undenuded watershed by 55 per cent.

Of the total annual excess of flow from the denuded watershed (0.96 inches), 0.68 of an inch came down before the crest of the flood, 0.12 during the decline of the flood, 0.09 in the summer months, and nearly 0.07 inch in the five winter months.

The most striking effect of denudation was the increase in the average annual silt load carried to the dam by the stream from the denuded watershed. While before denudation this silt load was 568.5 pounds, after denudation it became 3340 pounds.

The conclusion reached by the investigators is that the removal of the forest cover increased the flow during all stages —the spring flood period, the low summer flow, and the winter period, and that

this increase was brought about not through elimination of transpiration by the leaves of the forest trees, but through eliminating the interception of the snow by the tree crowns, thus allowing the snow to reach the ground, melt, and add its share to increase flow from the watershed.

What is the real meaning of these conclusions? When translated into plain English, I think, it is this: The effect of the denuded watershed upon the water balance, with the exception of the silt load, is insignificant. The effect of forest cover upon streamflow is greatly exaggerated; furthermore, if the interests of irrigation are to be considered, the watershed denuded of forest cover makes available a greater amount of water during all stages than the forest-covered watershed.

One need not seriously question the correctness of the conclusions considering the data on hand and the conditions with which the investigators dealt, and yet refuse to accept them as having any general application. These conclusions can be true only for the limited local conditions studied. Any attempt to generalize from these conditions would be extremely misleading. The results are inconclusive and could not be otherwise because of the character of the areas selected for the experiment. As the authors themselves point out, one could not expect any radical changes as the result of denudation where the original ratio of high to low stages is only as 12 to 1 and where the denudation could increase this ratio only to 17 to 1. The results would be entirely different where the normal ratio of high to low stages would be 25 to 1. This is a very moderate rate because ratios commonly as high as 50 to 1 and occasionally as high as 150 to 1 or even higher do occur.

The watersheds selected lie in a region of low precipitation, of which half comes in the form of snow. Although the summer rain comes in the form of afternoon thunderstorms, it is seldom of great intensity. The average rain intensity during June and July rarely exceeds 0.3 inch. During the 15 years covered by the investigation, only a single heavy 24-hour rain occurred. These light rains, intercepted by the foliage of the aspen stands and evaporated back into the atmosphere, may account more for a loss of water from the forest-covered watershed than the interception of snow by the bare trunks in winter.

The soil was coarse and sandy, containing and covered by many small rock fragments, conducive to a very high degree of absorption of rain and snow. Even without any vegetative cover, there would be very little surface run-off from such a soil, and the quantities of soil eroded were actually very small.

The forest itself—an open aspen stand of poor development with shallow roots spreading near the surface—can hardly be considered a normal forest cover. Even this open stand of weak development, when cut, was almost immediately replaced by aspen root suckers. These, together with the herbaceous vegetation that sprung up after the denudation, tended to restore within a short time the original water balance on the watershed. Such conditions are not typical over large mountainous areas, even in the Rocky Mountains. The reviewer recalls his early experience on Mill Creek in the Gunnison National Forest. The soil was of a sticky, heavy nature. After even

a light rain, the mud would stick to the shoes. The Gunnison National Forest drains into the Colorado River, and the soil there is probably as representative of a part of the Rocky Mountain conditions as the particular watersheds on the Rio Grande.

It has become almost an axiom that in any experiments in which the effect of a single factor is to be studied, one must select conditions in which this factor plays a dominant part. In the study of the effect of forest cover upon the water regimen of a watershed, one would naturally look for watersheds in which the forest is dense, well developed, and where its removal does produce a radical change in the cover of the watershed. There would be an entirely different story to tell in a region of heavy summer precipitation, heavy unpermeable soil, and dense cover of real forest. Those who were familiar with the Wagon Wheel Gap investigation from its early inception pointed out that no conclusive results could be obtained as to the effect of forest upon streamflow on the watersheds selected for the experiment. The results now presented merely confirm this prediction. Although it may be very unfortunate that after nearly sixteen years of costly and careful observations, we are not further advanced in solving quantitatively the problem of the effect of forest cover upon streamflow than we are today, still the Wagon Wheel Gap experiment leaves us richer in experience and knowledge as to the methods of approaching a similar problem elsewhere. If it is not a final contribution to our knowledge of the relation of forest to streamflow, it is a valuable contribution to forest meteorology.

RAPHAEL ZON.

The Root System of Pine (*Pinus sylvestris*): A morphological investigation. By E. Laitakari. *Acta Forestalia Fennica 38, Helsingfors, 1927.*

This monograph of the valuable series which has been issuing from Finland at frequent intervals during the past two or three years, is of especial value because of the stimulated interest in root development as an index of habitat conditions which has arisen recently, principally as the result of Weaver's work in this country. The monograph under discussion is one of 300 pages of text, a good though not extensive bibliography,[1] 50 pages of excellent illustrations, and a 74-page summary in English. This last is so complete that the reader is compelled to refer to the Finnish text only to find the tabular corroboration of the statements made. The reviewer does not attempt to go beyond the English summary.

The investigation occupied several summers. The method employed was to dig the roots out, layer by layer, recording the depth and size of each root at regular radial distances from the center of the stump, and all of the branching within each of these concentric circles. Depths were measured from the surface to the top of the root, regardless of its diameter. There was undoubtedly some breakage and loss of roots, in spite of the greatest care, especially in stony soils. It is to be regretted that so exhaustive an investigation could not have had the

[1] As the author points out, serious investigations of the root development of plants have been comparatively few in number because of the large amount of labor involved in them, which undoubtedly accounts for the small number of titles in this bibliography.

benefits of the hydraulic method of excavating.

The density of the horizontal root system was determined by laying off the entire root area in squares of one meter and merely determining the number or proportion of such square which contained roots of any size. Where a slight shifting of the locations would change the result, the average of two or three tabulations on different bases was accepted.

The growth of the main horizontal roots is described as frequently attaining a rate of 12 inches per year in young, vigorous trees, and in general as going through a cycle very similar to that which characterizes the height growth of the tree.

Considerable space is devoted to matters pertaining to the thickness, shape, and arrangement of the roots as they appear to be of mechanical significance. We shall mention but one point in this connection which appears to be clearly substantiated by the data. This is that the main direction of the horizontal root system appears to be influenced by the direction of the prevailing winds in summer. The greatest number of unsymmetrical root systems extended markedly toward the southeast, while the weather records for Suomi show that winds from this direction are least frequent and weakest. Laitakari explains this by the suggestion that the roots on the sides of the trees from which the winds come with greatest strength, most notably the southwest side, are shaken in the soil and "encumbered," with resulting retardation of their development. This seems logical, but it is certainly "bad medicine" for those who are inclined to give a mechanistic explanation to phenomena involving the localization of plant foods. These may, however, glean some comfort from an examination of the data on root thickness and buttressing. The correspondence between root direction and crown direction (where unbalanced) is extremely weak, the author pointing out that while summer wind direction may influence crowns to correspond with the main root direction, there are obviously more important factors working toward discordant results, among which is winter wind from different directions.

In considering the significance of root developments in relation to habitats, besides moors and bogs three general types of soil are recognized—sandy, morainal without stones, and morainal with stones. Any of these soil types may occur in any of the vegetation types, which, following the custom now almost universal in Finnish literature, are described in agreement with the occurrence of certain "indicator" plants. Thus the types used in covering Scotch pine occurrence are the Calluna, the Vaccinium, the Oxalis, and the Myrtillus, the two last often being considered in combination. Of these the Calluna type is apparently the poorest in productivity.

The longest horizontal roots on pine were found on sand heaths, the greatest length being 23.5 meters. Roots in excess of 15 meters are, however, exceptional. Even this spread is much greater than that of any of the crowns.

Roots grown on moraine or gravel soil without stones also develop considerable length, while the presence of stones seems definitely to curtail their development. A rich, partly-dried peat did not produce long roots, while a poor wet one

did. In general a "poor" type favors great root length.

Site conditions being equal, total lengths of root systems are about proportionate to the diameters of the trees. For this reason, in a number of instances the factor of variable diameters is eliminated by dividing root length by diameter.

On this basis, the length of roots on the Calluna type is not appreciably greater than on the better types, but the sum of the lengths for a given tree is to some extent greater on the poor type, meaning, of course, somewhat more numerous roots or branches and greater density within the root area. This tendency for the Calluna or poor type to produce the greatest total length of roots is less marked on stony soils than on those in which there is no interference. In contrast, the poor wet peat site which produced very long roots had a much less total length of roots than the good drained peat sites. The few spruces examined followed the same rule as the pines.

The densities of the root systems (meters of horizontal roots per square meter of root area) remain fairly constant under different conditions, or, in other words, total length and area occupied vary in about the same proportion. However, there was a variation in density from 1.0 to 3.2 on firm lands while the very highest density was obtained by one of the trees growing on rich well-drained peat, namely 5.1. Old trees generally show a greater density than young trees, the latter being engaged in extending their roots before they fill in the intermediate spaces.

Although the depths of the horizontal root systems do not vary widely either with age or site, the sandy land pines are in general the most shallow-rooted. Some very superficial roots occurred on soils rich in stones. There is also a tendency toward a deeper extension of the roots in the better forest types. The depths on peat were variable and seem to bear no consistent relation to the water levels of the several moors.

The positions of the root systems with reference to the soil layers can be found only by comparing the average depths of the roots with the average depths of the layers, since the positions for individual roots were not recorded. Occasional trees have their horizontal roots entirely or almost wholly in the humus layer. Others extend their roots into the brown layer (Horizon B) below the leached layer, to a very large extent. Of 49 trees growing in soils where the leached layer was distinct, however, 23 trees had average root depths so shallow as to indicate that the bulk of the roots must be in the leached layer.

While the Scotch pine is a tree generally known to develop a tap root, it does not do so on moors or dense clayey soils, and on moraine or gravel soil the "regular" tap root cannot develop. Apparently, however, from the observations of this writer and others, even where there is no obstacle to the formation of a tap root, it does not occur as regularly in the northern regions as in central Europe. Using a very restricted definition of a tap root, namely that it must be practically a downward extension of the main stem and that it must not branch except at its very tip, Laitakari finds that only 38 per cent of the trees examined by him had true tap roots, but, excluding the trees on peat and clayey soils, 64 per cent had roots which were approximately

vertical and whose depths exceeded twice the tree's diameter at the base. Tap roots often develop on young trees but later lose their distinctive character.

The inner vertical root system of pine is usually well developed, but particularly so in cases where the tap root is absent, and seems in a large measure to take the place of the latter. On sand soils especially the inner vertical roots are largely unbranched, while on the heavier soils they often spread into a broom or fan-like formation. The greatest depths, 3 to 4 meters, are found on sand soils and here seem to be determined by the level of the water table; in moraine and gravel soils the whole vertical root system often stops at the same level, often not reaching a depth of 1 meter. Not even small vertical roots were found in wet peat.

Scattered vertical roots, that is those developing from the long horizontal roots, are found on pine at great distances from the tree, and in general their depth seems to be controlled by the same factors which limit the depth of the central vertical root system. The scattered roots are usually of small diameter.

Additional discussions are given of the form of the central root system, the cubic contents of the root system, the roots of small seedlings, and intergrowth of roots. The extreme figures for volume noted were 95 per cent of the stem volume for a young tree growing on a drained peat, and 15 per cent of the stem volume for a slender dominant tree growing on stony moraine soil in the Vaccinium type. In general the proportion of root volume decreases as trees become older; it is also less on good than on poor sites.

The significance of the root systems of earlier generations of forest is discussed, it being pointed out that particularly in sand heaths the old decaying roots and their channels are important for the development of young trees. The author concludes, however, that this is of less importance in northern countries where there seems to be less tendency for the tree to depend on a deep root system.

Based on a few sample trees only, it is shown that spruce has a root system which in total length and area is greater than that of pine. The spruce root system also bears a higher relation to the volume of the stem than does that of pine, and is shallower.

It is to be regretted that such comparative features as those last mentioned were not stressed more in this study, for, after all, comparative biology is the most illuminating and gives the direct basis for an understanding of the growth phenomena of the forest.

C. G. Bates.

The Principal Biochemical Law. By Professor S. L. Ivanov. *Bulletin of Applied Botany and Plant Breeding, Vol. 16, No. 3, 1926. Leningrad.* (*Russian text with a brief summary in English.*)

The author introduces an interesting biochemical concept of great importance to all research workers in plant physiology, chemistry, and genetics. Professor Ivanov throws a new light on our understanding of the plant kingdom and of its evolutionary trends.

The biochemical law states that in a given environment every species of the plant kingdom produces chemical sub-

stances so peculiar to the species that they may be called its physiologic-chemical characters; that these characters show striking similarity when all genetically connected species are analyzed. The closer the genetic connection between the species, the more physiologic-chemical characters they have in common. Furthermore, the physiologic-chemical characters undergo evolution. As the genetic connection among the species becomes more distant, new substances are likely to develop in plants, exhibiting variations which are in simple chemical relation to the substance from which they developed.

This law, at least in the main, is well supported by the data and observations of many investigators from Rochleder (1854) to the present time. Rochleder, five years before Darwin's "Origin of Species" appeared in print, proclaimed that there was a definite connection between the position of a plant on the taxonomic scale and the character of chemical substances it produces.

This law suggests a natural system of plant classification. It is less subjective than the one based only on morphological differences. For instance, if a certain species of a certain genus produces the oil Ricinus used in medicine, then one may be quite certain that other species of the same genus produce an oil that has similar properties. In the Ericaceae family many species (*Ledum, Rhododendron, Vaccinium, Calluna*) produce arbutin, some (*Arctostaphylos*) methylarbutin, and some (*Gaultheria*) gaultherin, all of which are closely related chemically. *Eucalyptus globulus* produces the same ethereal oil no matter whether it grows in Australia, Algeria, or elsewhere. The ability of plants to produce specific substances is retained for a great period of time. Salicaceae were producing salicin in the Cretaceous period as they do now. It is interesting to note that before the Cretaceous period, the number of different chemical substances produced by plants was much less than since the Cretaceous period, when angiosperms began to appear and chemical evolution went at a higher rate.

The law is of equal importance in plant breeding. It is known that only closely related species can be crossed. This implies a similarity in physiologic-chemical characters. Two species producing different substances cannot be crossed. *Salix,* for instance, which produces salicin, and *Populus,* which produces populin, cannot be crossed. In crossing plants one has to be sure that they are chemically alike, at least qualitatively. Slight quantitative differences in chemical substances, however, may not prohibit crossing.

It is also interesting to know that the similarity of physiologic-chemical characters in plants connected closely genetically is verified by phytopathological observations on certain fungi and bacteria, the so-called monophages, which choose only plants with similar physiologic-chemical characters. Insects, too, show a preference for certain species.

The law tells us that organic substances undergo evolution. When a new species is developed its chemical structural formula is slightly modified but resembles that of the other species of the same genus or family. A new substance is produced as a result of the activity of ferments; to the original ferments a new ferment is added, causing oxidation, methylation, etc., and making the two very closely related substances somewhat different in their properties. *Strychnos*

species, for instance, producing strychnin and brucin, are generally poisonous while *Strychnos spinosa* is edible. The chemical character of a plant depends on its position in the taxonomic scale, on its habitat, and on the geologic epoch of its distribution. The chemical character of extinct plants could be approximately determined.

It should also be mentioned in this connection that Professor Ivanov showed in 1917 a definite relationship between the taxonomic position of a plant and the chemical composition of the oil produced by it. Oils of lower plants differ from the oils of higher plants. Linoleic acid ($C_nH_{2n-6}O_2$) is peculiar to gymnosperms and angiosperms, while acids of the type $C_nH_{2n-4}O_2$ or $C_nH_{2n-2}O_2$ are peculiar to lower plants such as mushrooms, mosses, and ferns.

S. R. Gevorkiantz.

Mitteilungen des Ausschusses für Technik in der Forstwirtschaft. (*Bulletin of the Technical Committee in Forestry.*) *Vol. 1, August, 1928, Berlin, "Der Deutsche Forstwirt." Pp. 82.*

When Dr. von Monroy had completed his year of graduate study in America under the Rockefeller Foundation, he returned to Germany and became the executive secretary of a newly created National Committee of the German Forestry Association (Deutscher Forstverein) to improve mechanical practices in the woods. The art of forest utilization in Germany had never reached the high point of mechanical advances characteristic of American forest industry, and in other phases of forest management the same is true. This bulletin is the first to appear and embodies the results of a series of exhaustive tests conducted on various mechanical devices, some of which are of interest to American foresters.

The first test was of two types of mechanical cross-cut saws: one, a chain saw manufactured by Ring and Co., Berlin; the other a motor-driven dragsaw of the Witte Engine Works of Kansas City, Missouri. Time studies were made of the work of these saws on various species and under varying conditions and at once revealed fundamental difficulties in both types of saws. Until these are overcome, there is no substantial advantage in the use of these machines over the man-powered cross-cut saw.

The second test was for various mechanical seeding machines. These were tested (a) in the laboratory, (b) in the woods, and (c) by the resulting seeding. The machine known as "Walddank," manufactured by E. E. Neumann in Eberswalde at a cost of 220 marks (about $55), was found to be the best.

Further tests were made of a harrow well adapted to stirring the forest soil before broadcast sowing, or as an aid to natural reproduction, a ball plant lifter for nursery practice, a grub hoe with two blades instead of one, and a new type of turpentine chipper. None of these is particularly impressive for American practice.

Finally, the committee reports on a new type of marking tool—somewhat like a scribe—mounted on the end of a stout cane and covered, when not in use, by the usual ferrule. This instrument costs 8 marks and is available through Oberförster Wagner, Boppard-on-the-

Rhine. It permits approach to very branchy stems, hard to reach with a marking axe.

In a letter of transmittal, Dr. von Monroy, whose address is Potsdamerstrasse 134, Berlin W. 9, asks for the cooperation not only of German foresters in bringing to his attention new devices but also of foresters elsewhere, particularly in the United States, to which he pays the compliment of great ingenuity in labor-saving devices.

The bulletin, the first of a series, is obtainable for a price of 2 marks (about 50 cents) at the address indicated above.

A. B. Recknagel.

The Timber Industrial School of Finland. Brief Summary of Activities, 1921-1926. *Pp. 40 + 107; pl. 110. Published by the School, Viipuri, Finland, 1927.*

A description of the activities of this school is of interest to American foresters because of the present interest in vocational training.

The Timber Industrial School at Viipuri, Finland, was founded in 1921 and has for its purpose the training of foremen for forest, logging, floating, and sawmill activities. The school is under government subsidy but owes its inception largely to the efforts of the Finnish Woodworking Association. It is thus a vocational training school for the timber industry. Entrance requirements include completion of public school and two years' practical experience in logging camps, in floating work (river driving), or at sawmills, and the applicant must, in addition, pass an examination in arithmetic and spelling. Between 1921 and 1926 certificates have been granted to 249 students, 85 of whom specialized in the forest and floating foremen's course, and 164 in the sawmill foremen's course. Of these 92 per cent remain in the industry for which they were trained.

The period of instruction covers two semesters, each of 15 weeks' duration. Following the spring term the student is required to employ 6 months in a sawmill or 3 months in the woods and on the streams used for floating. The place of employment must be approved by the head master and a report is required at the end of the employment covering the student's observations. The class room work during the autumn includes studies of arithmetic, algebra, geometry, mechanics, steam engines, drawing, building construction, surveying, wood technology, management, accountancy, sociology, and the Finnish language. In the spring the class room work covers more mathematics, heating and ventilating, gas engines, electricity, map drawing, accountancy, Finnish, industrial law, forestry, timber estimating, logging, floating, river improvements, sawmill machinery, sawing, selling and shipping, elements of machinery, building construction, and sawmill plans. Practical exercises and excursions to logging camps and mills form an important part of the instruction.

Apparently only two of the instructors reside permanently at the school; the remainder are practical men who visit the school weekly or teach on a per-hour basis.

This volume is somewhat like an American school yearbook. There are cuts illustrating the school equipment, floor plans, and the like, and pictures of

instructors, trustees, and graduating classes. To make the book of particular interest and value to those desiring an idea of the extent of the timber industry in Finland, there are 95 pages of very clear half tones depicting forest, floating, sawmill, storage, and lumber handling activities. A few of these pages are devoted also to picturing the pulp and paper industry. These views were taken at many operations while the classes were on field trips.

EMANUEL FRITZ.

On the Buoyancy of Pine Logs. By S. Boberg and M. Juhlin-Dannfelt. *Journal of the Swedish Forestry Society, April, 1928.*

In this article the authors discuss their experiments at the Kloten School of Forestry on changes in the buoyancy of pine logs. The principal conclusions follow:

1. Pine logs stored in calm water increase in weight at the start on account of the penetration of the water, but during the hottest season of the year a reduction in weight occurs regularly even in timber which is stored entirely immersed below the surface of the water.

2. The heart content appears to be more of a determining factor in buoyancy than the width of the annual rings.

3. Pine logs may possess perfectly satisfactory buoyancy from a timber-driving point of view if the heart does not amount to more than 15 per cent of the end area of the logs.

4. Timber entirely submerged in water displays very approximately the same changes in weight as that floating on the surface of the water.

5. The retention of the bark on pine logs appears on the whole to augment the increase in weight.

In the English summary are described in detail the authors' method of determining weight and buoyancy; changes in volume of logs stored in water; reduction in weight of logs floating or submerged in water; and factors influencing floatability of logs. The article should be of interest particularly to pulp producers who depend upon river driving for log transportation.

EMANUEL FRITZ.

NOTES

SOURCE OF FOREST TREE SEEDS.[1]

Instructions by the Swedish Forest Service recently sent out to forest supervisors bring out the importance of the source of seed used in artificial reforestation.

In this respect the following rules have been given out, concerning especially the eight most northerly forest districts, which shall be taken into account in the procurement and use of pine seed:

Pine seed shall not be sown in a district where the normal temperature for the summer deviates more than 0.5° C. (0.9° F.) from the corresponding temperature in the region where the seed was collected. It is desired that this difference in normal temperature be as small as possible in each case. The normal temperature is taken as the average for the months of June to September, reduced to sea-level and the corresponding isotherm, based upon a deduction of 0.5° C. of temperature for a rise of every 100 meters in elevation (1.37° F. for 500 feet difference in elevation).

In collecting pine cones and in seed cleaning, they should be segregated by regions. Cones obtained by the forest personnel in the forest district should be segregated according to the elevation in the district in which they are obtained. Cones obtained at from 0-100 meters above sea-level should be put into Zone 1; 100-200 meters, Zone 2; 200-300 meters, Zone 3; etc.

Cones purchased from the government seed establishment should be listed according to the province and elevation, as for example Norbottens lappmark, Norbottens coast land, etc.

Purchase of pine seed from other than the government seed establishment may not take place, since it is doubtful that the necessary seed collection data are available according to the newly promulgated classification.

In seeding areas with pine seed, the following should be observed:

When using seed obtained from the same forest district wherein the sowing is being done, care should be taken that seed should be used from cones obtained from the same elevation zone to which the seeding area belongs.

In using seed obtained from the government seed establishment, or other seed dealers, the difference in the normal temperatures between the seeding area and the seed collection area shall be determined according to the method given previously. This difference shall not be over 0.5° C. (0.9° F.).

To aid in the determination of elevation zones, forest officers should requisition the General Staff's lithographic station map sheets which are handled through the Forest Service. For the determination of the normal summer temperatures, the isotherm map showing temperatures for June-September should

[1] Translated from "Skogen," February 1, 1928.

be obtained. This is given in the article, "An Observation with Artificial Reforestation," by O. Eneroth, in "Skogen," Vol. 4, 1926. On this map are shown isotherms for the temperatures in question at sea-level from 11° to 15° C.

E. J. HANZLIK.

DETERMINATION OF FOREST SEED QUALITY

The following essentially is a brief from the Russian of V. G. Kapper's article "On errors in the determination of forest seed quality" in Vol. 33 of the Leningrad Forest Institute, 1926, pp. 158-198:

In testing seeds, much of the primary concern of an investigator is with the accurate determination of their quality. Painstaking work and good apparatus alone do not insure the results against errors that may be inherent in the method of attack. It is quite reasonable, therefore, to adopt methods which, without losing their practicableness, would limit the chance of occurrence of some significant errors, which might otherwise pass unnoticed.

Considerable information on the procedure of testing seed quality has been supplied by the Union of German Agricultural Stations (1909-1916). The Union recommended that seed for the samples be taken from the upper, middle, and lower parts of each bag in which it is usually distributed and that these samples be well mixed. If there are more than 20 but less than 100 bags of seed to be tested, the samples should be secured as described above from at least 20 bags. In case seed is not packed, the samples should be obtained from at least ten different places and from the top, middle, and lower portions in each case.

Four hundred seeds (200 in each set) are recommended for germination tests. The individual results of the test should not vary from the average more than is shown in the table below. If the variation is greater, the deviating sample should be set aside and a new one used instead. Another rule is that if the difference between the highest and the lowest germination per cent values exceeds 10 per cent for seed with high germination, or 15 per cent for seed with low germination (say around 50 per cent) the experiment should be repeated.

Germination per cent	Allowable deviation of individual results from the mean in per cent
0.0– 5 or 99.99–95	4.2
5.1–10 or 94.99–90	5.7
10.1–15 or 89.99–85	6.8
15.1–20 or 84.99–80	7.7
20.1–25 or 79.99–75	8.3
25.1–30 or 74.99–70	8.8
30.1–35 or 69.99–65	9.1
35.1–40 or 64.99–60	9.4
40.1–45 or 59.99–55	9.4
45.1–50 or 54.99–50	9.6

Later Schwappach observed that top and middle portions of bags gave germination from 6 to 7 per cent lower than the lower parts if considered alone.

Studies of the methods of obtaining samples for germination tests are still needed to minimize as much as possible the error in assuming that the sample is truly representative of the total material from which it is taken. The Russian seed experiment stations use the rule that the weight of the sample should be equal to one per cent of the total weight of seed, if the latter does not exceed 360 pounds. The weight of the sample, however, should not be less than 1/9 pound

for birch seed, 2/9 pound for pine, spruce, and larch seed, 4/9 pound for fir seed, and about 4½ pounds for linden and oak seeds. If the total weight of seed exceeds 360 pounds, the samples should weigh not less than 9 pounds for oak, and about 2¾ pounds for other species.

Much attention should be given to a systematic procedure in obtaining seeds for samples. This will guard against personal equation and bias. It is known, for instance, that pine seeds darker in color give higher germination than those lighter in color. Also cases are known where small seeds are eliminated from samples and are thrown away with impurities. Only broken seeds should be eliminated from the sample.

The use of Jacobsen's germination apparatus has already gained universal recognition. The germination tests should be conducted under the conditions of temperature, moisture, light, and aeration required by the particular species. Before placing the samples in the apparatus, Kapper soaks the seeds in water for 24 hours at room temperature (19-20° C.). The temperature of the water in the apparatus is usually about 24° C. at 10 A. M., then it increases 2° every hour, reaching a maximum of 36° C. at 4 P. M., after which it gradually drops down to 24° C. This range of temperatures is well within the range given by Jacobsen himself (20-30° C.).

The accuracy of viability tests depends on the number of seeds used. Many foresters have been using 100 seeds in a sample; some even less. Different stations, according to Rafn, would get different values of germination per cent sometimes varying as much as 20 or 30 per cent. Only Nobbe recommended as early as 1876 the use of at least 200 seeds and for accurate work between 400 and 600 seeds. His statement was then not well appreciated. Swedish, Norwegian, and Danish stations now use 600 seeds for germination tests. The Stations in Budapest and in Holland as well as Austrian and German Stations use 400 seeds. Haack and Busse recommend taking three sets with 200 seeds each. Rodewald, considering errors to which the theory of probability could be applied, came to the following conclusions:

1. The accuracy of determining germination per cent depends on the number of seeds used in a sample.

2. The average error of the mean of all observations and the probable error increase as the germination per cent decreases from 100 to 50, reach a maximum at germination of 50 per cent, and then decrease in the same proportion until the germination per cent becomes zero. With a given number of seeds, errors in germination per cent of 90 and 10, 75 and 25, etc., are the same.

3. The reduction of the error due to increase in number of seeds, after more than 400 seeds are used, is not rapid.

4. The probable errors make it possible to set the range of allowable variations of the values of individual tests from the average, depending on the accuracy which is desired. Rodewald gave the following convenient table of standard errors of individual observations in germination tests, which is based on the theory of probability. Columns for samples with 300 and 500 seeds were added by V. G. Kapper.

Probable errors, if needed, can be obtained from this table by multiplying the values of the standard error by 0.6745. The Union of German Agricultural Stations uses too broad a range of allowable

Rodewald's Table of Average Errors (Standard Errors) of Individual Observations

Germination per cent	Number of seeds in a sample							
	100	200	300	400	500	600	800	1000
	Standard errors of individual trials							
95	2.180	1.542	1.208	1.090	0.984	0.890	0.7709	0.6895
90	3.000	2.121	1.731	1.500	1.348	1.225	1.060	0.9486
85	3.572	2.525	2.011	1.786	1.596	1.492	1.263	1.129
80	4.000	2.829	2.198	2.000	1.787	1.633	1.415	1.265
75	4.330	3.062	2.498	2.165	1.935	1.768	1.531	1.370
70	4.582	3.241	2.644	2.296	2.046	1.871	1.620	1.449
65	4.769	3.372	2.753	2.384	2.123	1.946	1.686	1.508
60	4.899	3.464	2.827	2.449	2.189	2.000	1.732	1.549
55	4.975	3.518	2.871	2.487	2.224	2.031	1.759	1.573
50	5.000	3.536	2.885	2.500	2.234	2.041	1.768	1.581

errors, *i. e.*, in the neighborhood of six times the probable error. In more recent statistical analyses the range of ± 3 times the standard error, or about $4\frac{1}{2}$ times the probable error, is more generally recognized. Analyzing this table we see that the standard errors for samples with 100 seeds are twice as large as those for samples with 400 seeds and three times as large as for those with 900 seeds (not presented in this table).

In Europe they consider the seed for distribution purposes with germination of 85 per cent as seed of average viability. In the United States, however, the average germination per cent would vary from 70 to 85. Taking the limit of error from 5 to 6 per cent, as evident from Haack's studies and using the rule that variation becomes significant beyond the range of three times the standard error, we see from Rodewald's table that a sample of 500 seeds is necessary to attain this accuracy. For more accurate work when the limit of error is placed between 4 and 5 per cent, 800 seeds should be used. More viable seed would require smaller samples and poorer seed (not less than 50 per cent) larger ones.

Experimentally, using the results of tests on 256,000 and 132,000 spruce seeds, Kapper came to the same conclusion that ordinarily 500 seeds should be used for the germination tests and that 800 seeds are sufficient for scientific work.

At the same time, Kapper points out the fact that the range of allowable variations as given by the Union of German Agricultural Stations is rather too broad, that out of 776 samples (500 seeds each) not one showed such large deviations. The opinion of the writer of this note is that three times the standard error or possibly five times the probable error would give a satisfactory range of allowable variations and perhaps a much sharper criterion of their significance.

Whatever is true in regard to germination per cent is also true in regard to germinative energy or the germination per cent during the first third of the germination period.

The absolute weight of seed, or the weight of 1000 seeds, can be determined on the average within one per cent. The error of individual trials may be as high as 5 per cent. It is better to obtain the weight of 2000 seeds and then divide the result by two.

For purity tests, the instructions of German Agricultural Stations give the following allowable errors: For purity

per cent of 97 and higher the allowable error is one per cent, for purity between 90 and 97 per cent and lower than 90 per cent the errors are two and three per cent respectively. This was once more affirmed by Kapper's data.

S. R. GEVORKIANTZ.

THE ROOT SYSTEM OF THE HAZEL[1]

Large areas of the cut-over pine lands in the Lake States, especially in Minnesota, are occupied by dense stands of hazel brush, often to the exclusion of any tree species. The cover is made up of two species, *Corylus americana* and *Corylus rostrata,* in varying proportions.

The fact that the pines and other conifers seem to be unable to establish reproduction under these hazel stands could be attributed to lack of light, due to the density of the hazel, or to the lack of moisture caused by root competition.

As no information was available in regard to the roots of the hazel, a fair specimen of a large bush was selected at the Cloquet Forest Experiment Station and the roots dug up. This bush was composed of 59 stems varying in height from 6 inches to 8 feet. The aggregate length of all the sprouts was 232.5 feet; the average height 3.94 feet.

The soil was a coarse sand grading into gravel in small pockets and apparently underlain with gravel at a depth of from 3 to 4 feet.

As no equipment was available for washing out the roots, they had to be dug. In spite of great care, many of the roots were broken. Whenever possible, they were spliced together again, but in some places it was impossible to find the pieces broken off. Probably not over 1 to 2 per cent was lost in this way.

The roots were, for the most part, found in the upper foot of soil. At the ends, where the running roots broke up into fibrous masses, they sometimes went deeper. In two or three cases, apparently where the roots struck pockets of gravel or very coarse sand, they turned down at almost a right angle to a depth of three feet.

The roots were, on the whole, very slender. Few of them were any larger than the forefinger at the root collar. Some extended 6 or 8 feet without material reduction in size. There they branched strongly, usually ending in a bunch of rootlets as fine as threads. Roughly speaking, the roots filled a rectangle 15 by 18 feet; roots 11 feet long extended to the four corners.

The number of stems in this bush is evidence of a wonderful ability to sprout, but there was no indication of the formation of any suckers from the roots. Each bush is apparently an individual.

Neither time nor money was available to measure all of these roots carefully; nor did it seem justifiable to measure them with painstaking accuracy when it was known that some of them were lost in the digging.

In order to save time and expense, it was necessary to estimate the fibrous roots. As the fibrous roots varied greatly at different points on the running stems, it was necessary to select a number of samples as a basis for an estimate. Therefore four six-inch sections of the main roots were selected to represent, as nearly as possible, an average of all of them: one from near the crown, two from in-

[1] Published with the approval of the Director as Paper No. 816 of the Journal Series of the Minn. Agr. Exp. Station.

termediate points, and one from the far end. The side roots on each of these six-inch sections were carefully measured to a tenth of an inch as follows: 0, 15.6, 37.8, and 79.6. The average of these four was 33.2 inches. In other words, each inch of running root represents, together with attached fibrous roots, a total of 6.5 inches.

The running roots were then carefully measured and aggregated a total length of 13,900 inches. By applying the factor 6.5, an estimate of all roots is obtained of 90,350 inches, or 7529 feet.

This study covers only one bush and the data are too meagre to warrant many general conclusions, but it is enough to indicate that root competition might play a very important part in the life of seedlings planted in hazel brush. Where the bushes are growing in dense stand, the ground must be literally matted with the roots. Moreover, this accounts for the roots of only one species. There were, in addition to the hazel roots, many feet of roots of the bracken fern, blueberry, honeysuckle, and many other smaller plants.

It would seem that a more extended and more thorough study of the roots found in the forest soil of different types might result in some very interesting discoveries in a little known field.

E. G. Cheyney.

Increased Growth of Released Hemlock

Under natural conditions eastern hemlock (*Tsuga canadensis*) ordinarily reproduces and passes its early life in partial or full shade. It is able to establish and maintain itself for long periods under conditions of suppression which would prevent the establishment of many other species.

Frothingham[1] stated that the period of suppression in hemlock commonly lasted from 30 to 70 years but might continue for more than 200 years if the forest remained closed. He found that even at advanced age, however, a suppressed tree will respond to liberation, and once it attains a dominant position will grow fairly rapidly in diameter and volume.

Merrill and Hawley[2] presented data in support of the statement that the rate of diameter growth (at breast height) of hemlock after liberation is increased almost two and a half times. They further stated that observation on a limited number of trees indicated that height growth also increased greatly after the trees were freed from a hardwood cover.

Marshall[3] found that the diameter growth (at breast height) was increased five and a half times after liberation of hemlock by removal of a pine overwood. Well-stocked stands exhibited 60 per cent better recovery than sparsely stocked stands.

The Wheeler-Dusenbury Lumber Company, in northwestern Pennsylvania, has operated for many years in stands containing hemlock either in mixture with white pine and hardwoods or pure. Recent cuttings on their rather extensive holdings were made in stands which followed logging in the virgin forest about 65 years ago. These recent cuttings made

[1] Frothingham, E. H. 1915. The eastern hemlock. U. S. D. A. Bul. 152.

[2] Merrill, P. H., and Hawley, R. C. 1924. Hemlock: its place in the silviculture of the Southern New England forest. Yale School of For., Bul. 12.

[3] Review of Jour. of For., 26:374-375, 1928.

it possible to study the rate of diameter growth in hemlock before and after release from suppression.

The area on which the study was made originally supported a mixed forest composed largely of hemlock, white pine, and hardwoods, such as beech, sugar maple, red maple, yellow birch, and red oak. The original cuttings made some 65 years ago did not remove the small hemlock or all of the small hardwoods. Since horse logging was employed on the operations and fire protection afforded, the advance growth hemlock survived and developed into a nearly pure stand which was profitably logged again 65 years after the original cutting was made.

The operations of the Wheeler-Dusenbury Lumber Company in Fork Run, a tributary to Tionesta Creek in Forest County, Pennsylvania, furnish an excellent large scale demonstration of the capacity of hemlock for rapid growth after release from suppression.

An examination of 38 stumps resulting from the recent cutting indicates that after release the hemlock grew almost three and a half times as rapidly in diameter (at a stump height of 18 inches) as it did before release. The increase in growth is most marked in trees of small diameter at the time of release (up to 5 inches) and relatively less in larger trees. On the whole, the actual rate of diameter growth is higher both before and after release in trees over 5 inches stump diameter. This might be expected since the larger trees usually occupy a more favorable position in a stand than small ones, and also have more fully developed root systems.

The rate of growth under conditions of suppression appears to be directly proportional to the stump diameters of the trees (*i. e.,* small trees grow very slowly, and large trees less slowly).

The summarized data taken in the study in Forest County, Pennsylvania, are given in the following table. The determinations of age and diameter were made at an average stump height of 18 inches.

RELATION OF SIZE OF HEMLOCK TO RATE OF DIAMETER GROWTH BEFORE AND AFTER RELEASE FROM SUPPRESSION

Diameter class before release	Number of years to grow 1 inch in diameter		Basis, number of trees
	Before release	After release	
1........	29.7	5.5	7
2........	20.8	5.6	5
3........	19.2	5.1	10
4........	17.5	3.7	3
5........	18.1	3.7	4
6........	15.4	5.7	2
7........	10.0	4.8	1
8........	9.4	3.4	3
12........	9.0	5.9	1
14........	9.0	3.7	1
16........	8.3	4.2	1

It appears that hemlock is a species which can endure long periods of suppression and recover quickly and make fairly good growth when released. On release the rate of diameter growth may be increased from two and a half[2] to five and a half times[3] the growth before release. It appears that the variable increase of diameter growth after release reported by different workers may be due to such factors as density of stocking, diameter and age of the trees released, and severity of suppression and extent of release. Since hemlock is able to grow on practically all upland forest soils within its commercial range, from

the poorest on thin, rocky soils to the best on deep, rich soils, it should find increasing importance in silviculture.

H. J. Lutz.

An Occupational Study of Graduates in Forestry from Cornell University

To what extent do those who have completed their college work in forestry make direct use of their training, and in what fields?

To answer this question satisfactorily would require no little effort on the part of investigators. Yet it is exactly detailed information of this character that will be required if a thorough analytical study of the relation of school curricula to subsequent occupation is to be completed.

During each of the past seven years the writer has given a little time to an occupational study of the men who have completed their forestry training at Cornell. The statistics cover occupational data for the past seventeen years, from 1911 to 1928. The first analysis was made in 1921, and since then an annual revision has been made.

The results of the latest revision, made in 1928, are given in Table 1. This shows for all living graduates the total number in forestry and in other lines, and for those still in forestry the particular field of employment. There is no duplication in the figures presented, since those who have secured both their Master in Forestry and Bachelor of Science degrees at Cornell are included only in the columns dealing with the men that have secured the graduate degree.

Table I

OCCUPATION OF LIVING GRADUATES IN FORESTRY, CORNELL UNIVERSITY, JUNE, 1911, TO SEPTEMBER, 1928

Line of work	Degree of M. F.		Degree of B. S.		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
All Graduates						
Forestry	39	72	73	43	112	50
Other	15	28	95	57	110	50
Total	54	100	168	100	222	100
Graduates Remaining in Forestry Work						
Federal	13	33	14	20	27	24
State	5	13	5	7	10	9
Private	14	36	44	60	58	52
Teaching	4	10	3	4	7	6
Postgraduate	0	0	6	8	6	5
Foreign	3	8	1	1	4	4
Total	39	100	73	100	112	100

The facts of chief interest brought out by this table are as follows:

1. Approximately half of the total number of living graduates are now in forestry work of one kind or another.

2. A considerably larger proportion of men taking the M. F. degree remain in forestry than of those taking the B. S. degree. This is probably due in large part to the fact that the graduate students as a rule include only those who have definitely made up their minds that they wish to go into forestry as their life work. Among the undergraduates, on the other hand, it occasionally happens that an individual, prior to graduation, decides to go into some other line of work, but because of the rather highly specialized curriculum in forestry, prefers to complete his work for a degree in that field rather than to suffer the loss of time that would be involved in transferring to another department or college. Furthermore, the fact that the postgraduate students are men of greater maturity and better professional training has resulted in giving the first choice of positions to that group.

3. A much larger proportion of M. F. men as contrasted to the B. S. men are found in federal work. This is undoubtedly due in large part to the fact that until two years ago only graduate students were encouraged to take the civil service examination for junior forester. It will be interesting to see how this situation changes, now that the schedule of studies has been modified so that the seniors are better fitted than before for the examination.

4. Practically the same number of M. F. and B. S. men are found in state work.

5. Private work gets the largest proportion of both classes of graduates, although the 60 per cent of men with the bachelor's degree in this field is far above the 36 per cent of the men with the master's degree.

6. It may appear surprising to find that a few of the men securing only the bachelor's degree at Cornell are in teaching work, but all of the 3 men (4 per cent) in this class secured their master's degree at another university.

An analysis of the occupation of living graduates by years from 1921 to 1928 shows that the proportion of men with the master's degree in federal work has decreased from 52 to 33 per cent, and of those with the bachelor's degree, from 23 to 20 per cent. This downward trend in the number of men employed in federal work is accompanied by an upward trend in the number of those in state and private work and in teaching. Since it is difficult to believe that the data concerning Cornell graduates are greatly at variance with those concerning other forest schools, this raises pointedly the question as to why the proportion of men entering federal employ should be on the down grade. This is particularly true in view of the fact that, at Cornell at least, every effort is made to interest men about to complete their college work in the Forest Service.

The average young college graduate of today is a keen, energetic young fellow who has his eyes and ears open and who thinks for himself. He analyzes what the United States Forest Service has to offer him. He sees many boys dropping out after a year or two. He investigates the situation, and he often decides that he does not think the work is constituted, at present, in a way to offer him a sufficiently attractive future. It is not that he is afraid of hard work, dissatisfied with the entering salary, or unwilling to go through the necessary period of apprenticeship, but he is not willing to spend a large part of his life in that department.

He may be wrong, but that is his way of looking at the situation.

Many of these men make excellent records for themselves, in forestry or other lines of occupation, and it is unfortunate that more of them do not go with the Forest Service. It would seem that the profession might well give some study to seeing what could be done toward developing a field which would attract these younger men, not with a view of giving them a few years of training, but with the idea of more permanent employment. If the Forest Service is to get its share of the most able men, it would do well to recognize that the situation exists, and that it is one that must be solved.

C. H. Guise.

Education Beyond the Four-Year College Course in Forestry.[1]

Is the fifth year at a forestry school worth the extra time and money involved? Just how much does this further education cost? These are common questions of the student about to graduate from a four-year forestry school. Usually his professors advise him to take the fifth year if he can possibly finance it. On the other hand, out on a forestry job during the summer he finds men whose judgment he values advising against the fifth year of school and belittling it in comparison with the experience gained by the same time spent in the woods. Often these same foresters have master's degrees in forestry. Such differences of opinion are very perplexing to the four-year man in considering the question. Each year he observes an increasing number of students taking the master's degree. Could this be just a growing fad in forestry, or are these men really getting something worth while?

It is the opinion of the writers that the ones best qualified to answer these questions are the graduate students who have just been through the "mill." They can appreciate better than the older men what the costs are, for they can each cite an actual instance in terms of present-day prices. And again, they may be able to advise as to the value of a fifth year better than the older men, because they can clearly differentiate between the knowledge and capabilities they possessed before their master's work and after it. Also present day forestry courses may be more valuable to a student than the forestry courses of the past, as the pedagogy of forestry advances with the developing profession. Therefore, if his views and financial facts are recorded, the fifth year graduate may be in a more favorable position to help the younger student.

The cost of taking a fifth year at a school of forestry during an academic year, as shown by carefully kept expense accounts of several students, is as given on page 1052.

Slight modifications were necessary in certain items, where the consensus of opinion of the graduating students indicated that the entry was not representative. A few students spent about $200 more than the totals, on clothes and entertainment, while others were able to reduce the cost by a similar amount, especially on the items "meals" and "clothing." Thus the totals given here indicate the approximate expense one can

[1] From Yale Forest School News, Vol. 15, No. 2, with additional figures.

	From a leading school in the West	Mid-west	East
Tuition	$200.00	$133.00	$200.00
Graduation fee	5.00	17.50	20.00
Laboratory fee	10.00	....	10.00
Thesis, typed and bound	10.00	8.00	13.50
Lodging (38 weeks)	152.00	190.00	171.00
Meals	290.00	250.00	300.00
Clothing and laundry	137.00	105.00	143.00
Business expense (carfare, stamps, forestry club membership)	20.00	33.00	35.00
Toilet articles, haircuts, etc.	9.00	12.00	13.50
Entertainment (shows, dances, football games, etc.)	20.00	66.00	75.00
Academic and personal equipment (paper, books, photos, etc.)	50.00	46.00	45.00
Total	$903.00	$860.50	$1025.00
Optional items of personal character (such as dental work, association fees, gifts, and trips on pleasure to other cities)	80.00	130.00	150.00
Grand total	$983.00	$990.50	$1175.00

expect in taking a fifth year. The comparison of the regional costs should not be used in concluding that it costs less to take a degree in one region than another. The personal equation far outweighs this regional factor.

The amount of about $1000 for a fifth year may seem to the undergraduate student a formidable obstacle in gaining a master's degree. This is especially true if the student must travel a long distance to the school of his choice for his master's work; the railroad fare becomes an added item of considerable importance. However, there is an increasing tendency among the forest schools today to offer a greater number of fellowships, scholarships, and loans to students in order to lessen the financial burden. A glance at the catalogs of the various schools shows this to be true. It is interesting to note that 50 per cent of the seniors at one school had added to their finances during the year by $200 or more through scholarships or work aside from their studies. The practice of outside work should be reduced to a minimum where real graduate work is to be accomplished during the year. However, the financing of a fifth year for a forestry student is no longer as insurmountable as it once may have seemed.

The question of whether or not a fifth year is worth while must be considered. It is an established fact that each year an increasing proportion of four-year forestry men returns to college for a master's degree. This degree, therefore, annually grows to bear less distinction than it formerly possessed, for the large number of such degrees granted each year tends to rob them of their individuality. Yet it has changed from a mark of distinction to a necessary asset in a man's qualifications for many of the better positions in forestry.

One sometimes hears the remark that a fifth year is necessary for the man who

expects to go into research work or teaching, but for the administrative man, practical experience in the field cannot begin too soon. Still, there are excellent courses offered in certain of the schools on forest policy and economics which are as fundamental and necessary to the young administrator as advanced courses in silvics may be to those inclined toward investigative work. In many ways the advantages of taking a fifth year and obtaining a master's degree are quite clear.

On the other hand, there can be found those students who are just completing their fifth year and are disappointed in what the year has meant to them. These instances in the senior classes have been observed with interest and an attempt made to determine the cause for such disappointment. It has been found that the students who are most enthusiastic about their fifth year are those who have performed work of truly graduate caliber. They elected to work out single problems in the subject they were most interested in and enrolled in several courses of a broadening character in new fields. These men were thus really doing graduate work during their fifth year. But the students who came to the school and filled up their schedules with course work, much of which covered subjects they had previously been over in their undergraudate school, were the ones disappointed and received the poorest grades. Their work during the fifth year could not be classified as graduate work, though they received a master's degree at the end of the year. The repeating of subject matter and the following of a routine schedule just like an undergraduate, proved their undoing and their interest lagged. Thus to get the most out of the fifth year, the student must actually do graduate work—a fact very often overlooked. This presupposes, of course, that all students desire graduate work and are capable of performing it.

Another frequent mistake of a four-year man when taking a fifth year is to continue at the same institution from which he received his bachelor's degree. This deprives him of many advantages: the mental stimulus which a change always brings; the acquaintance with new professors and new points of view; the backing of a second institution, which means widened sources of recommendation and interest in personal welfare; and, finally, the possibility of choosing for the single year of graduate study a school superior in specialized fields to the one in which circumstances placed him for undergraduate work.

These points with regard to a fifth year for four-year forestry students may be summarized as follows:

1. A fifth year at a first rate forestry school will cost about $1000. This amount is often made less burdensome through fellowships, scholarships, loans, or work aside from the regular studies.

2. A master's degree is each year becoming more necessary as a qualification for forestry work, even though the increasing number granted each year causes a decrease in the distinctiveness of the degree.

3. A plan of study should be chosen, based upon a special problem, which will call for individual effort and thought. Certain courses in new subjects should also be taken if the student's interest is to live and the greatest benefit be obtained from the extra year.

4. Equally important is the chosing of a second institution for the fifth year, rather than continuing at the same school.

James L. Averell.
Seldon T. Huntting.

First Discovery of Sugar Pine

Henry E. Hardtner, of the Urania Lumber Company, Urania, Louisiana, calls attention to the following statement which appeared in the American Masonic Record and Albany Saturday Magazine, Vol. 1, No. 41, of November 10, 1827:

EXTRAORDINARY PINE TREE

In Dr. Brewster's *Journal of Science* there is an account of one of the most extraordinary species of pine trees yet known. It is given in a letter to Dr. Hooker, from Mr. Douglass, the botanist.

" I rejoice to tell you of a new species of *Pinus,* the most princely of the genus and probably the finest specimen of the American vegetation. It attains the enormous size of 170 to 220 feet in height, and 20 to 50 feet in circumference. The cones are from 12 to 18 inches long; I have one which is 16½ inhces in length and which measured 10 inches round in the thickest part. The trunk is remarkably straight, and destitute of branches till within a short space of the top, which forms a perfect umbel. The wood is of fine quality, and yields a large portion of resin. Growing trees of this species, that have been partly burned by the natives to save the trouble of cutting other fuel (a custom to which they are generally addicted), produced a substance which, I am almost assured in saying, is *sugar;* but as some of it, with the real cones, will soon reach England, its real nature can be easily and correctly ascertained. The tree grows abundantly two degrees south of St. Columbia, in the country inhabited by the Umftgun tribe of Indians. The seeds are gathered by the natives in autumn, pounded and baked into a sort of cake, which is considered a luxury. The saccharin substance is used in seasoning dishes in the same manner as sugar in civilized countries. I shall bring home such an assemblage of specimens of this *Pinus* as will admit of a very correct figure being made, and also a bag of its seed."

$50,000 to Study Termites

An outstanding example of cooperation between industry and science is the newly organized " Termite Investigations Committee " with secretarial headquarters in San Francisco. Business men and scientists have combined in this committee for a thorough study of the life histories of termites and for possible methods of their control.

Termites, or as they are erroneously called white ants, have long caused a great deal of damage to forest products. They have always been with us, but ever since man so completely upset the balance of nature he unwittingly improved the living conditions of his insect enemies. They are at work in almost every part of the country, and in some other parts of the world they are vastly more destructive than they are in the United States. In southern California, the public service corporations owning pole lines

have lost heavily because of the attacks of one species of termite working in the butts and another species working in the dry upper portions. Here and there, also, some destructive work in residences and commercial buildings has elicited public notice. Termites, for many years, have been most interesting subjects of research for biologists,—their structure, physiology, and social life have made extremely fascinating study. Biologists, entomologists, and foresters are repeatedly called upon for advice as to methods of combating termite attacks. Usually their advice has included some warnings as to the danger of inaction when infestations become known. It has become axiomatic that losses to business and industry are suffered to go on until they assume large proportions, when a few of those who have lost most heavily are aroused to energetic action from which the less interested and less active also benefit. Such was the case, for example, with the invasion of marine borers into San Francisco Bay waters ten years ago, an invasion that caused losses to marine structures totaling over $15,000,000 in less than three years. That catastrophe brought about the formation of a committee to study these marine pests, with the result that so much light was thrown upon the subject and so much new knowledge on methods of control was obtained that an engineer can now be accused of culpable negligence if he does not heed the recommendations in that committee's report.[1]

This experience bids fair to be repeated in the studies of the Termite Investigations Committee. It happens that some of the losers from termite attacks were members of or contributors to the committee that investigated marine borers. That experience caused these men to sense the danger and to take the initiative during the past summer in the formation of a committee to make a similar and even more thorough study of termites. Its organization is now completed and it has been given the name of "Termite Investigations Committee." No more definite title as to region was adopted because the problem is more than state-wide and it was desired to make the investigation as broad as possible. The committee is already launched upon a three-year program which may have to be increased to four or five years, and it has over $40,000 pledged with $50,000 the goal for a three-year program.

It is interesting to know the business of some of the contributors. Among the leaders are the following: the California-Hawaiian Sugar Refinery and Matson Navigation Company, whose joint chief engineer, Mr. A. A. Brown, is chairman of the general committee; the Southern Pacific Railroad, whose chief engineer will act as vice-chairman; the Charles R. McCormick Lumber Company, whose sales-manager, Mr. J. Walter Kelley, is acting as secretary-treasurer; the Pacific Telephone & Telegraph Company; the Pacific Gas & Electric Company; the Southern California Edison Company; the National Lumber Manufacturers Association; and the State Board of Harbor Commissioners. The professional and business men guiding the work of the committee are outstanding engineers and executives, men of such vision and energy that the success of the committee's work is assured.

[1] A review of the final report of the San Francisco Bay Marine Borer Committee appeared on page 815 of the October, 1928, Journal of Forestry.—Ed.

One of the first acts of the general committee was to form a technical advisory council selected from members of the faculty of the University of California. The chairman of this council is Dr. C. A. Kofoid, under whose masterful scientific direction will be conducted the biological investigations. Other members of this committee, some of them also heading sub-committees, were enlisted from the departments of chemistry, entomology, agricultural chemistry, and forestry. The members of the advisory council also serve upon the executive committee.

The actual investigative work is in the hands of Prof. S. F. Light, of the University of California's department of zoology, who has for many years made termites a major study in many parts of the world. He has employed several trained field and laboratory assistants and has started on a very intensive study of the habits of termites, particularly in California. Among the sub-committees are the following: Biology; Chemistry; Protection and Tests; Pole Lines; Lumber Yards and Producers; Engineering Specifications; Historical and Service Records; Finance; Building Departments and Railroad Structures; and Publicity.

The object of this note is not only to report the formation of this committee, but also to draw attention to what may be done when business and science can be gathered around the same table. A visitor attending the meeting of the executive committee would be impressed by the character of the discussions. The business and industrial members lean upon the scientific men for technical information and assistance, while the scientific men submit to the practicality of the business men.

EMANUEL FRITZ.

New Insect Attacks Paper Birch[1]

During the last three seasons the early browning of the paper birch foliage in Maine has been very noticeable, and has attracted wide attention. In August and September when the foliage on other hardwoods is green, that on paper birch begins to look as if it had been scorched by fire. In certain sections of the state where paper birch predominates, whole hillsides and valleys look brown.

The insect (*Phlebatrophia mathesoni* (?)) causing this injury is a sawfly leafminer apparently of European origin. The insect is new to this country and specimens sent abroad correspond very closely to a similar species in the British National Museum. The insect is of an unusual type in many respects and its life history differs from most leaf miners. During the past season, the Maine Forest Service made a preliminary investigation of this new pest and the following paragraphs set forth the results to date.

Early in July, small four-winged, black-bodied flies appear around the birches. They are about one-half the size of an ordinary house-fly with a single dark band on each otherwise transparent wing. Flying to the foliage of paper birch they cut or saw a slit on the margin of the leaf with a saw-like appendage that gives them the name, sawfly. In the pocket thus made the insect inserts an egg. Each individual lays on an average about twenty-five eggs, usually not more than three to a leaf. It taken about ten days for the eggs to hatch and the young larvæ begin to slowly eat out the tissues of the leaf. By the first of August, small brown patches begin to show up on the edges of the leaves. As the larvæ

[1] From Maine Hardwood News, Vol. 1, No. 6, Oct. 1, 1928.

become larger, the mined areas grow rapidly in size and by the first of October the foliage has been quite completely mined. The larvæ then form a round flat cell in the leaf which is waterproofed with a waxy secretion. The winter is spent in the fallen leaves in this cell. Late in June the larvæ transform into the adult or fly stage and break through the leaf tissues.

Throughout their entire life the larvæ are admirably protected from such enemies as parasitic insects, diseases, birds, or adverse climatic conditions. Although hundreds of the insects have been reared and studied we find almost no enemies. One of the most remarkable features about the insect is that there are no males. This greatly influences the rapid multiplication of the pest, for each individual is capable of laying fertile eggs.

We have yet to learn just what the outcome of this outbreak will be, and it is extremely dangerous to make definite predictions. It is the writer's understanding that during the fall of the year the foliage on the trees is manufacturing storage food to carry the tree through the winter and start the new growth in the spring. From this it can be seen that fall defoliation is extremely serious. White birch artificially defoliated in the fall of 1927 was quite seriously affected. The foliage this year was smaller than normal and the leaves had a slightly yellow tinge. Trees which for two years were infested with the leaf miner put on very little growth this year. In fact the growth on many trees examined proved to be only from one-eighth to one-half normal.

Control of the insect is still a thing of the future. Individual trees may be protected by spraying with a nicotine sulphate spray diluted one to four hundred, with the addition of one ounce of dissolved laundry soap to each gallon of spray. Trees should be sprayed the latter part of July. This spray proved almost one hundred per cent effective. Trees were also sprayed with repellents early in July but nothing definite came from this. Preliminary examinations tend to show that certain forest types in which the birch occurs in mixture with other species are relatively immune.

Considerable confusion has been caused in the minds of some people on account of several other birch leaf pests. The birch leaf skeletonizer is a moth which lays its eggs in June on the leaves. These hatch into a grub that at first mines in the leaf and later emerges and eats the epidermis from the underside of the leaf, skeletonizing it. Another leaf miner attacks the leaves of gray and paper birch in July and August but has not been in epidemic form. A new insect which lives in a tiny cigar-shaped case causes small holes to appear in the leaves late in the fall. Several species of leaf rollers turn and web over the edges of birch leaves, feeding within this roll.

This coming year it is hoped that a further study of the insect can be made that will bring out possible means of control. Notes of the unusual occurrence of this insect will prove of considerable help if sent to the Maine Forest Service. The possibilities of airplane dusting have not as yet been tried in Maine although other states and the Canadian Government are obtaining remarkable results in controlling forest insects by this method of attack. It seems quite possible that a repellent dust might be used to check

the birch leaf-miner, particularly in areas where there are large quantities of valuable paper birch.

H. B. Peirson.

Forest Plantation Experiments on the Choctawhatchee National Forest

One of the most interesting studies under way in forest research in the South is that of reforestation on the Choctawhatchee National Forest in western Florida. This study, conducted under the supervision of the Southern Forest Experiment Station, consists of two phases—(1) the natural reproduction of longleaf pine, and (2) methods of artificial reforestation in this region. In this note the latter phase only is discussed.

Natural reproduction of longleaf pine is very scant on the Choctawhatchee Forest. This appears to be due to a number of causes, apparently the most important of which are adverse conditions of soil and climate. The soil is a very light sand, in composition practically pure quartz, and with the prevailing sunshine often reaches extremely high temperatures. Insufficient rainfall is not unusual. During the past century, fires have occurred frequently and seed years have been altogether too infrequent to restock the culled-over timber before scrub oak and other vegetation have taken over the ground. The Forest Service, having "inherited" the forest in this condition, has confined itself principally to giving adequate fire protection, hoping that this would improve the site to such an extent that when a good seed crop occurred conditions would favor natural reproduction. However, where seed trees were few and seed years occurred only at intervals of four to ten years, it began to seem more desirable to reforest such areas artificially.

Before such work was undertaken on an extensive scale, the Experiment Station was called on to conduct a series of tests to determine the most feasible methods. In the winter of 1927-28 a series of plantations was established on a culled-over area near the Camp Pinchot Ranger Station to determine the possibilities of planting longleaf seedlings. Five methods of planting were used: (1) Planting under living brush (scrub oak and hawthorn); (2) planting in grassy openings from which the effect of roots of the surrounding oaks had been eliminated by means of trenching the entire area; (3) planting in the open on plowed land; (4) planting on plowed land and covering the seedlings with cut oak brush; and (5) planting seedlings on cleared, unplowed land, and covering with oak brush cut during clearing.

Supplementary plantings in the living oak brush and on the plowed land were made with both slash pine and Monterey pine.

Survival records taken in October, 1928, showed the results indicated in the table on page 1059.

The losses which occurred during 1928, the first growing season following the planting, might be attributed mainly to the following causes:

1. Inability to take root. A longleaf pine seedling early forms a long tap root and in lifting the seedling from the nursery it is necessary to cut the tap root to a length of about eight inches, a shock from which some seedlings never recover.

Species	Method	Survival, per cent
Longleaf Pine	Natural Brush	60
	Trenched Openings	60
	Plowed (open)	38
	Plowed (brush covered)	65
	Brush cut and used for cover	43
Slash Pine	Plowed (open)	62
	Natural Brush	40
Monterey Pine	Plowed (open)	44
	Natural Brush	8
Cypress	Plowed	83
	Natural Brush	85

2. Incorrect planting. Frequently the tap root was not placed straight into the ground but was bent back, resulting in failure to take hold.

3. Root exposure.

4. Excessive transpiration and high soil temperatures which occurred while the plant still had a minimum of established root system. The losses on the plowed land are due chiefly to the combination of these causes.

5. "Salamanders," which destroyed the roots in their process of tunnelling. A moderate loss resulted from this cause.

The 1928 growing season was exceptionally favorable to these plantations because of frequent rains. It is believed, however, that improvements in planting technique will go a long ways toward the successful establishment of seedlings even under less favorable conditions.

E. W. Gemmer.

Surveying Going Fires with an Airplane

The airplane, which proved its value as a vehicle for detailed observations over vast areas during the World War, is still a worthy ally in the ever-present warfare against forest fires, particularly in the far West.

The Los Angeles County Forestry Department, in conjunction with the U. S. Forest Service, has realized the highly important place aviation now plays. During the past two years these organizations have had an agreement with the Western Air Express for the use of one of its ships, for the express purpose of patroling the mountainous areas during the fire season from about the first of May until the coming of the winter rains, usually in December. The ships are also used to great advantage during a going fire, as the following incident related by C. M. Meredith, assistant fire warden, will show:

"On September 24, at 4.30 p. m., this office received a call from the U. S. Forest Service, asking if we had a man available to fly over the Ridge Route fire and make a survey of the extreme western boundaries. Such a survey involves the plotting of the fire on U. S. topographic sheets, with crosses to show where it is burning most rapidly.

"I started at once, and after crashing traffic for what seemed like hours arrived at Vail Field on Telegraph Road, the terminal of the Western Air Express, where a Douglas Mail Plane, Type M. 2 was warming up. After a hurried discussion about the thickness of the

weather, we slipped into our 'chutes, climbed aboard, taxied out, headed into the wind, and were off at 5.15 p. m.

"While I was arranging my maps and getting ready for a hurried survey of the fire line we were gaining altitude. We found that the ceiling was very low and off to the west the fog was rolling in thicker than the well-known pea soup. A pall of smoke lay over the rest of the surrounding country. I began to fear that we should fail in letting the men on the ground know that evening the direction of the fire and at what points it was making the most headway, so that they could make use of the information during the night when conditions for fire-fighting are usually most favorable.

"When we reached the fire I slipped out of my safety belt, grabbed my map and pencils, oriented myself, and the fight was on. Being in the forward cockpit I did not have the vision that I would have had in the rear cockpit, as the wing assemblage prevented me from looking over the side and straight down. I tried standing up, but my 'chute seemed to get into every conceivable position that would annoy me, the slip stream from the stick buffetted me about, and the air currents over the fire made the going bumpy. Then the pilot took a hand and through his capable and skillful handling of the ship made my work considerably easier by banking the ship to the right or left at such an angle as to give me better visibility. Finally, about dark, he started for Saugus Field where we landed at 6.40 p. m.

"There we were met by a car which took us to Newhall headquarters, where I telephoned the result of our survey to the U. S. dispatcher at Pasadena. Then two copies were made from the original survey and rushed to the camps on the fire lines where they were carefully gone over to determine the logical place to attack the fire. That night several hundred men were put on the fire line at the hottest spots and as a result the fire was declared under control the next day, September 25. A subsequent check showed that in spite of the adverse conditions the survey, which had been made in one hour and twenty-five minutes from landing to take-off, had been 90 per cent correct."

FRED GOODCELL.

THE FARDI RANGE FINDER AS A WOODS INSTRUMENT

An instrument which would rapidly determine the distance between two points at a cost less than that of pacing or of chaining would be of great use to the forester, especially in mapping and cruising. However, a new instrument, to prove feasible, must meet certain practical requirements as to cost of operating, permanence, and ease of adjusting, ease of training the operator, and standard of accuracy as set by the combined errors of the instrument and the average operator.

The Fardi range finder, which is made in 20 and 40 centimeter lengths, consists of a tube fitted with a three-powered Galilean telescope as an eye-piece at one end, a fixed prism at the other end, and a moveable prism at the center. In using the instrument, the eye-piece is focused so that two images are seen; a graduated circle attached to the center prism is then turned until the two images coincide,

when the distance, in yards, to the object sighted can be read directly from the graduated circle. The accuracy as given by the manufacturers is ± 1 per cent for the longer and ± 2 per cent for the shorter instrument.

The adjustment of the instrument is easily and quickly made, either by making sure that coincidence occurs at infinity or by measuring a given distance on the ground and verifying the reading on the graduated disc. If the adjustment is inaccurate, it is only necessary to loosen the graduated circle, turn it to the desired reading and clamp it solidly in place. When rectified, it is a good plan to check the adjustments by a few tests.

The use of the range finder is so simple that a novice soon becomes adept at the art. However, in trying to use it in a dense stand of second-growth Douglas fir, a wide divergence of results was obtained between measurements made by different men, and between different readings by the same man. Investigation showed that a large share of the inaccuracy was caused by the operator's inability to select the proper sighting object.

In order to test the accuracy of using the instrument under various conditions, a series of ten readings at a distance of 25 yards was taken under each of the following conditions and the standard error computed. The results were as follows:

Nature of object sighted	Standard error in per cent
1. In dense stand of second-growth Douglas fir:	
a. With no special care to identify the particular tree sighted	20.6
b. A peculiarly shaped tree allowing a good check on the tree sighted	12.7
c. A limb with a contrasting background of blue sky	1.6
d. A bright tatum placed against the tree	1.2
2. In the open:	
a. Ordinary bend of a small stream	16.9
b. A stump with a contrasting background	0.0

It appears, therefore, that the accuracy of using the present instrument is primarily dependent upon the definiteness of outline of the object sighted. On work which does not require an accuracy greater than the inherent accuracy of the instrument and which will also allow the selection of objects for sights with a clear-cut outline, the Fardi range finder undoubtedly effects a saving in time without a reduction in accuracy.

Earl G. Mason.

Pulpwood Transportation Costs [1]

The cost of transporting pulpwood from forest to mill is an important item in the total cost of pulpwood. In an attempt to measure its importance, data on actual transportation costs were solicited in the survey of the pulpwood situation for the third quarter of 1928. It is felt that the reports received from 55 mills are sufficient to permit at least a preliminary analysis in each of the more important papermaking regions.

The data were averaged by weighting each report in proportion to the pulpwood consumption of the individual mill. These weighted averages, together with significant ranges, are shown by regions in

[1] From "Pulpwood," Vol. 1, No. 6, Nov., 1928.

the following table. In a few cases the cost of hauling wood from the stump to the landing or railroad siding is included in the transportation cost, particularly where the wood was driven. Most of the data, however, pertain only to the major transportation costs from landing to mill.

The weighted average of all reports, amounting to $3.23 a cord, comprises 25 per cent of the weighted average f. o. b. mill of all pulpwood reported during the third quarter. The weighting used in this calculation does not conform exactly with the regional distribution of the pulpwood cut as computed by the Bureau of the Census in 1926. If the weighting is altered to conform with this more exact basis, and if allowances are made for regional costs which are plainly out of line, the United States average transportation cost amounts to about $3.65 per cord. This comprises 27 per cent of the average f. o. b. mill cost of pulpwood weighted on the same basis.

Average Transportation Costs of Pulpwood by Regions

Region	Number of reports	Weighted average	Range of costs: Low	Range of costs: High
		Per cord		
United States	55	$3.23	$ .50	$11.00
Maine	4	3.76	1.50	5.25
Vermont and New Hampshire	4	1.71	1.10	2.00
New York	5	8.56 [1]	3.60	11.00
Appalachian States	2	6.65	3.50	9.50
Michigan	6	3.26	2.50	6.00
Wisconsin	16	3.23	2.00	7.50
Minnesota	4	2.96	2.40	5.00
South Atlantic States	4	1.95	1.25	3.00
Louisiana and Texas	3	2.04	1.00	3.25
Pacific Coast	7	2.12	0.50	2.50

[1] Costs on imported wood only.

In the regions where the paper industry has been long established, transportation costs are high; but in the more recently developed regions they are low. These variations are directly attributable to the relative distances of the average pulpwood haul. This is largely a matter of the abundance and the distribution of remaining timber supplies. Transportation costs are, therefore, a partial index of timber depletion.

The mills in New York draw a larger part of their pulpwood supply from outside the state than do the mills of any other state. The high average transportation cost reflects this situation. The extremely high figure shown is not a fair average, however, for it is based entirely upon imported wood, which comprised but little more than one half of the pulpwood consumed in the state in 1926.

The average transportation cost of $6.65 in Pennsylvania is also high because of local depletion. The Maine average of $3.76 covers both imported and domestic wood and both rail-hauled and driven wood. The low figure for Vermont and New Hampshire is of course based upon local supplies.

The Wisconsin and Michigan averages indicate relatively long hauls. A large part of the spruce used in Wisconsin

comes from without the state, necessitating long hauls. The average charge on wood originating within the state averages $2.50 per cord, but spruce pulpwood shipped into the state averages $6.54 a cord. The spread in transportation charges of over $4.00 per cord indicates the importance of the local hemlock forests. The relatively high Michigan average reflects the fact that more than one half of the mills in the state are located in the southern peninsula, while the bulk of the remaining timber supplies are located in the northern peninsula.

The low averages in the South Atlantic, Mississippi Valley, and western regions indicate ample wood supplies within easy shipping distances. Many of the mills located in these regions find it unnecessary to ship wood more than fifty miles.

On the whole, there is little difference in total cost of water-borne and rail-shipped wood. The data do not permit, however, a comparison of these costs by units of distance. It is probable that such a comparison would reveal an advantage in favor of the water-borne. In the few cases of truck hauls which were reported costs were high.

The regional differences in costs of moving pulpwood from forest to mill are an index to probable future trends in the present low cost regions. Costs will not remain low in the new regions unless adequate measures are taken to use continuously for pulpwood production lands which are close to the mill. If local supplies are not maintained, the distance of hauling from woods to mill will increase as it has in the older regions, and costs will rise accordingly. The rising costs have been in the past a source of constantly increasing weakness in the cases of those companies which have not protected their mills with adequate land holdings and which have taken no measures to insure successive pulpwood crops. Furthermore, the wide differences in costs between the regions which now use local wood and those which are dependent upon distant wood indicate possible savings in the new regions which in many cases would undoubtedly offset the costs of forestry.

"Forest Gas"

The continued improvement of internal combustion engines using gas obtained from wood or charcoal is the cause of considerable elation on the part of some European foresters, who see in this new development at least a partial solution of the problem of high-priced gasoline and a new market for many of the present waste or low-value products of the forest and sawmill. Two articles, both by foresters, have appeared in the Bulletin de la Société Centrale Forestière de Belgique, Vol. 33, No. 9, and Vol. 34, No. 9, describing the success of the manufacturers in using wood and charcoal as the "carburant" both for stationary and mobile gas engines.

According to these articles, branchwood, shavings, sawdust, and other waste products can be used to obtain this "forest gas." Tests with tractors, touring cars, and busses are reported as successful, although some improvements are recognized as desirable. The material is used either raw or converted to charcoal, and either serves as the sole fuel or is mixed with gasoline. The apparatus as shown by photographs is not exceptionally bulky. A test with a Titan tractor util-

ized 100 kilograms of wood for 10 hours operation. One company is installing motors of this type on 50 canal boats.

The foresters extol the possible benefits of this new development in the practice of forestry. Not only will forestry be able to assist the country by furnishing a much needed fuel at a lower price, but the market for branchwood and the waste products of manufacturing plants is expected to be greatly improved.

H. T. Gisborne.

The Use of Canes by Foresters

In reading Professor G. R. Eitingen's pamphlet called "Sketches of German and Swedish Forestry" (Moscow, 1926), in which he describes his recent visit to these countries, the writer of this note came across a paragraph concerning the simplest known hypsometer, devised by Professor Busse, the director of the Forest School at Tharandt.

It is really worth while to know this instrument, which is nothing but an ordinary cane with three conical tacks on it. One tack is placed a little below the handle, another 7 centimeters below it, and the third 63 centimeters below the second or 70 centimeters from the first.

In order to measure the height of a tree, the cane is inverted and is held vertically by an observer in his stretched arm so that the line of sight passing through the third tack comes on the tip of a tree. At the same time, the observer, by going away from the tree or toward it, tries to get the base of the tree on the line of sight through the first tack, thus "catching" the total length of the tree between these two sights. After this is done the observer notes on the tree stem the point at which the stem is intersected by the line of sight through the middle or second tack. The intercepted distance from the base of the tree to this point of intersection can then be measured by the observer and it will give him, as we know from geometry, 1/10 of the total height of the tree. For example, if the line of sight through the second tack cuts the tree 6 feet above the ground, the total height of the tree is 60 feet.

Professor Busse states that this cane hypsometer gives ample accuracy for ordinary cruising work, for which purpose it is really made. Much, of course, will depend on the cruiser himself. Some may not be able to obtain accurate measurements with it, while others may find it reasonably safe. It does not take much time to make one nor to become accustomed to it. Who can tell but that the use of it might change the commercial status in America of this much despised article of dress?

S. R. Gevorkiantz.

Centenary of the Swedish Royal College of Forestry

The "Jubileum" of the Royal College of Forestry which was held in Stockholm on October 15, 1928, was much more than a celebration of the one hundredth birthday anniversary of that famous school. It was an occasion that was seized upon by the Swedish people to declare their enthusiastic approval of the institution which has done and is doing so much to shape the destinies of Sweden. For in her vast and cultured forests are sealed the commercial welfare of the nation. It is considered that perhaps the industries dependent upon the forests

have already passed in importance the iron and steel industry, and on "Skogshögskolan" rests the responsibility of training the personnel to administer and develop the Swedish woodlands. A mere recital of the program which was carried out cannot, in even the smallest measure, convey an adequate idea of the spirit that pervaded the gatherings. King and commoner, layman and scientist, joined whole-heartedly in making the occasion one which amply justifies the impressive volume of nearly 700 pages that has just been published in commemoration.

From fourteen foreign countries came delegates bearing the congratulatory messages of the schools and societies which they represented. It was the happy privilege of the present writer to represent the Yale School of Forestry and to speak at Konserthuset in behalf of the forestry schools of America. The University of Montana was represented by Dr. C. A. Schenck.

The Jubilee began on October 14 with an informal reception and dinner to the foreign delegates given at Skogshögskolan by the faculty. On the morning of the fifteenth formal exercises were held on the grounds of the college with addresses by the Rector, Professor Tor Jonson, and Count C. G. Mörner, chairman of the Student's Association. The afternoon program at Konserthuset was most impressive. There the representatives of many scientific societies and the foreign delegates presented their messages of felicitation. A banquet in the magnificent Golden Hall of Stadshuset, at which the Crown Prince delivered an address to the 1200 guests, was followed by a ball in the great Blue Room.

On the sixteenth the Swedish Forestry Association celebrated its twenty-fifth anniversary by formal meetings at Konserthuset, a luncheon at Kungstornet, and a gala performance at the Royal Opera. At all of these the foreign delegates were the honored guests of the Association.

Following the festivities an invitation was extended to those who came from abroad to take part in a delightful two-day excursion to the private forest estates of Herr Herman von Celsing and of Baron C. G. Bonde, both of which are near Katrineholm.

More, however, than with the material aspects of the celebration, the foreign visitors were impressed by the fine and enthusiastic spirit displayed by their Swedish hosts toward the subject of the national forest program of Sweden. If it be true that "in unity there is strength," then the Royal College of Forestry and the program which it fosters are just at the commencement of a new century of usefulness.

ROBERT P. HOLDSWORTH.

NEWS FROM OREGON STATE COLLEGE

John W. Blodgett, timberman of Michigan and Oregon, recently transferred to the School of Forestry of Oregon State College 2400 acres of cut-over land in the Douglas fir region of western Oregon. The land is to be used for research projects in natural and artificial regeneration. The area is located where site conditions for Douglas fir are at the best.

A research dry kiln has been added to the equipment of the school. The kiln is standard size as to cross section and will take material 22 feet in length. In ad-

dition to its use in research the kiln will be used for demonstration purposes before classes of sawmill men who desire technical training along dry kiln lines.

The Oregon Forest Nursery, a cooperative project under the provisions of the Clarke-McNary Law, will have about 500,000 seedlings and transplants available for distribution among the ranchers of the state this season. The nursery is located at Corvallis and is under the supervision of the dean of the school.

Third New England Forestry Congress

Advance notice of the Third New England Forestry Congress includes the following society members on the committee on arrangements: T. S. Woolsey, Jr., Chairman, P. L. Buttrick, Executive Secretary, R. C. Bryant, Treasurer, A. F. Hawes, Harris Reynolds, H. O. Cook, E. C. Hirst, A. C. Cline, H. B. Peirson, R. M. Ross, and Philip Ayres.

The date of the conference is February 1 and 2, 1929.

SOCIETY AFFAIRS

North Pacific Section Considers Legislation and Wood Waste

Speaking at the October 16 dinner meeting of the North Pacific Section in Portland, Ore., Ward Shepard, Secretary of the Society, stressed the point that the Sections should take legislative and political leadership in the promotion of the forestry movement in their regions; and should also take the initiative in a movement for cooperation with local organizations which are interested in the forestry movement.

The Society has aided in putting through several important legislative measures in Congress, according to Mr. Shepard, namely: the McSweeney-McNary Forest Research Act, the Clarke-McNary Reforestation Act, and the McNary-Woodruff Acquisition Act. The future work of the Sections should be to formulate new objectives for greater progress through:

1. Correlating objectives of various organizations interested in forestry.

2. Setting up of new visions and new objectives, and getting rid of inhibitions which are detrimental to forestry practice. These latter are mostly "under the hat," and not in the woods.

Mr. Shepard also mentioned the better and more efficient office procedure in the various Society offices, due to having permanent secretarial help as a result of the increased Society dues.

Carlile P. Winslow, Director of the Forest Products Laboratory, detailed his impressions of his western trip to logging areas and to industrial centers, and of the urgent need for more study by the Forest Products Laboratory of the western wood-waste problem. In this study it should be kept in mind that forest products must meet the needs and demands of consumers and also the prices of competing commodities. The problem of the timber owner and lumber manufacturer is to obtain closer utilization and to produce wood products with certain well-defined qualities to fit specific uses. For this purpose the variabilities of different species must be investigated, and then the selection of these properties for the various uses must be made in order to qualify for best use. There is also a large field for study in the control and modification of wood properties by silvicultural measures. Indications from a study of southern yellow pine are that large-crowned trees produce wood with a wide spring growth, and that a fertile soil produces trees with a greater proportion of summer wood. More is being done at the Laboratory in studying these relationships of physical conditions in the forest to the qualities of wood.

C. C. Heritage also from the Madison Laboratory discussed technical problems of pulp and paper manufacture from the research standpoint. He stated that good paper can be produced from all species of trees if the proper method of conversion is used, but that this is not economically feasible in all cases.

The problem of wood waste for paper manufacture includes material in the form of manufacturing waste, saw-mill, waste, woods waste, and round-timber waste (the latter being considered as under saw-log size). The two latter kinds of waste are the most difficult of solution because of the economic problems encountered. The range of finished products from wood waste is very wide, and includes such products as rayon, insulating material, and synthetic boards. This is also largely an economic problem. The solution requires a correlation of the sawmill and manufacturing plants for the further conversion of these wastes into products other than lumber.

In pulp and paper research of wood waste the first consideration is the use requirement of the consumed product, said Mr. Heritage. In the making of paper there are many variables, and we know the least about the forest variables, such as growth, forest environment, soil, and climate, as they affect the final product. The problem of utilization of wood waste is as important from an economic standpoint as it is from the technical.

Others called upon for a few words, responding in a more humorous than serious vein, were Haven Metcalf, of the Bureau of Plant Industry, Washington, D. C., and Fred R. Fairchild, Forest Economist, in charge of the study of the forest-tax situation for the United States, who now has a corps of men at work in the states of Oregon and Washington.

About sixty attended the meeting, of whom about one-half were members of the Society.

E. J. Hanzlik,
Secretary-Treasurer.

California Section Discusses State's Forest Problems

A meeting of the California Section was held in San Francisco on November 1, at which considerable business was transacted and several papers presented.

The Chairman was empowered to appoint a legislative committee, upon which all interests of the personnel represented in the Section shall be represented, to study and report upon legislative matters, and to act only when the unanimous opinion of the Section is expressed.

Plans for a meeting in December were briefly outlined, and the chairman was asked to appoint a committee to arrange for an all-day meeting on December 20.

A letter from H. A. Browning regarding the formation of a unit of the Society of American Foresters in southern California was read. The proposition in general seems to be excellent in the opinion of the members but the mechanics of handling it are open to considerable debate. Therefore, the Chairman was instructed to act independently in the matter in making recommendations.

A communication from Swift Berry urging the Section to endorse plans for an increased State budget for forestry purposes was read. State Forester Pratt explained in some detail what was contemplated,—more rangers, 12 look-outs, an inspector, 7 trucks, construction of fire breaks, etc., amounting to about a 90 per cent increase, mostly for fire prevention. A motion to endorse the movement for larger state expenditures was adopted.

The secretary was instructed to record with regret the passing of Dwight Birch, enthusiastic forester and able member of the California Section, and to write to

Mrs. Birch and the children a message of sympathy.

The talks of the evening all centered around forestry problems in California and how the Society can assist in their solution. S. B. Show presented the problems of the administrative work of the Forest Service. One problem is that of tying the men in the Service to the profession of forestry, especially in the case of the ranger and the partly trained man. The meeting proposed by the local section for December appears to be an excellent step in accomplishing this. Another problem is getting good men into the profession, which is obviously a job for individuals as well as for the Section as a body. In the matter of fire, the upbuilding of the state system of protection is very necessary at the present time, and appears to be a matter in which the body of professional foresters can play a part in getting adequate budgets for this work. Furthermore, it would help in the administrative problems of the Service if there could be constant scrutiny of the attempts at forestry that are being practiced on the National Forests. Foresters outside the Service should be familiar enough with the aims and accomplishments of the Service in the field to be able to constructively criticize this work.

State Forester M. B. Pratt spoke of the problems of protection in the brushland zone, where clean burns have developed extremely bad conditions. The attitude of the local inhabitants is not good and they often encourage fires to improve grazing, to collect insurance, to aid in prospecting, to destroy their neighbors' property out of spite, and to get a job fighting fire. Law enforcement is very poor owing to the attitude of local magistrates before whom convictions are almost impossible to get. The great question is, what is the brush worth? Are such fires to be fought simply to protect the National Forests? The effect of the ownership of watersheds by outside agencies, such as the East Bay Water District, also has considerable weight in determining the local man's attitude towards forest protection. The situation that has developed is very serious and needs the combined assistance of the entire profession to bring about a satisfactory solution.

E. I. Kotok spoke on the experimental work of the Forest Service. There are in California some 40 sample plots, some of them now nearly 20 years old. Most of them are entirely unknown to men of the profession who might travel to Europe to see plots of much less value than these. All members of the Section were invited to visit these sample plots and to take with them the pick of the public to see how the experiments look and how they are carried on. In an attempt to make the public come to its own conclusions, a critical and intelligent review of experiment station work is desirable, as well as assistance in drawing up the annual program. The profession can also assist the Experiment Station in telling them how to make results available to the profession and to the public. Members were invited to push the Experiment Station for results desired.

Walter Mulford discussed the problems of the school, pointing out that first of all it is desirable to find out what the school intends to do—whether to teach the basic background of forestry, or what might be called a vocational training. He pointed out that the training for science and for the profession are very different. Other problems of the School

are how to do research work properly and how to attract the highest class of material. The membership of the society is in an excellent position to give advice, not on technical research lines but how to train for the profession. The parent society has been wrestling with the problem off and on for some time. The local Section and the University of California should be able to handle the same subject in a much more concrete way locally. Mulford promised to move that a committee be appointed to determine what training is desired and help the School give it. Also he pointed out the difficulty of getting good men and advocated that a letter be sent to all the membership of the Section advising them to recommend good men to take up forestry.

In the absence of A. C. Horner, R. W. Smith spoke on the problems of the lumber industry, pointing out their vast number and complexity, and scoring the lack of action on the part of the leading men in the lumber industry. He stressed the importance of utilization in the field of forestry and pointed out that the industry seems to be lost in a fog of indecision and does not know which way to turn for a solution of its problems. He believes that foresters ought to be able to give good advice; but that forestry which stresses the production end is not moving in the direction to solve the difficulties of the lumberman. More attention should be paid to the utilization end and forestry should wade right in and endeavor to solve the difficulties of the lumberman.

In closing, S. O. Johnson spoke briefly in a rather amused way on European forests and forestry as compared with American, emphasizing that forestry on the ground was largely a mass of local problems, each one of which must be solved from a local standpoint.

F. S. Baker,
Secretary.

Northern Rocky Mountain Section Holds Bi-Monthly Meetings

The Northern Rocky Mountain Section held the first meeting of the winter season on November 19, 1928, at the Forest School of the University of Montana. The principal speaker of the evening was Prof. I. W. Cook of the University Forest School who discussed "Training of the Logging Engineer." Chairman White outlined briefly what was being done by the Kiwanians and others toward securing an enabling act for creating state parks and camp grounds in Montana. The outlook for the bill to be presented at the coming legislature was thought to be favorable.

The Section plans to hold bi-monthly meetings at Missoula through the winter and will hold a few additional meetings at Moscow, Idaho, Spokane, Washington, and possibly Kalispell, Montana. The annual business meeting and election of officers was to take place on December 3.

According to the Secretary's annual report, attendance at the 1927-28 meetings up to April 2, 1928, averaged 41, the largest attendance during any year to date. Members of the Section now number 130, of whom 36 are Missoula residents. The others are scattered through Montana, northern Idaho, and eastern Washington. Three reside in North Dakota.

Losses to the Section through transfer during the past year include C. A. Gillette, formerly Extension Forester of North Dakota, who left to take graduate work at Cornell; Harvey C. Jack, removed to Portland, Oregon; Robert Marshall, formerly assistant silviculturist at the Northern Rocky Mountain Forest Experiment Station who resigned to take graduate work at Johns Hopkins University; and E. W. Hartwell, assistant supervisor of the Custer National Forest, furloughed for postgraduate work at Ann Arbor.

In the way of additions we have Ferdinand W. Haasis, formerly with the Appalachian Forest Experiment Station and Secretary of the Appalachian Section, who now is instructor and one of the directors of the newly established Forest Experiment Station of the University of Idaho.

Section Members Visit New Forestry Club

On November 13 a number of members of the Intermountain Section made an automobile trip from Ogden to Logan and attended a banquet and meeting of the new Utah Agricultural College Forestry Club. The program and social features gave the members a good chance to become acquainted with 30 of the students who were present and to enlist their interest in the affairs of the Society.

Northern Rocky Mountain Section Elects Officers

Officers were elected by the Northern Rocky Mountain Section for the calendar year 1929, at a meeting December 3, 1928, as follows:

Chairman, C. D. Simpson, c/o Forest Service, Missoula, Montana.

Vice Chairman, F. G. Miller, School of Forestry, Moscow, Idaho.

Secretary-Treasurer, M. I. Bradner, c/o Forest Service, Missoula, Montana.

Members Executive Committee, R. N. Cunningham, c/o Forest Service, Missoula, Montana; John B. Taylor, c/o Forest Service, Butte, Montana.

Membership Committee: Chairman, E. E. Hubert, Forest School, Moscow, Idaho; Elers Koch; D. S. Olson; H. T. Gisborne; John McLaren.

New York Section Holds Summer Meeting in the Adirondacks

The New York Section held its annual summer meeting in the Adirondacks, September 5 to 7. A business session was held at Tupper Lake on the evening of September 5. The Secretary-Treasurer reported that, in accordance with the vote of the Section, $300.00 had been given the parent Society since January 1, 1928. This gift was made possible by a voluntary increase in Section dues for 1927, $10.00 each having been received from all but two Senior members, and $5.00 each from all but nine Members. Dues for 1928 are $2.00 for Senior Members and Members alike. They had been received from thirty-seven members up to September 5. A. S. Hopkins reported that $745.70, the balance on the Clifford R. Pettis Memorial Fund, is being held in a savings bank by the Memorial Committee pending the incorporation of the new church in whose cemetery Pettis' grave is located.

Entertainment by the New York Section at the time of the annual meeting of the Society in New York was discussed.

It was the consensus of opinion that the annual dinner of the Society should be the chief social gathering, and that members of the Society attending the meetings in New York would prefer other forms of entertainment to any other social function the Section might arrange. Other business conducted at the summer meeting was of local interest only.

On Thursday, September 6, the New York Section united with the Empire State Forest Products Association in a field excursion to a cutting on the slope of Panther Mountain (near Coreys, Franklin County, N. Y.). This cutting, on the land of Mr. Ferris Meigs, was marked by J. R. Simmons. Its object was to demonstrate the feasibility of cuttings in the Adirondacks which will be mutually satisfactory to the operator and the recreation interests. A complete report on this operation prepared by Mr. Simmons will appear in an early issue of the Journal of Forestry. Following the inspection of the Panther Mountain cutting, luncheon was had at the Forester's Inn at Coreys. After luncheon the group visited the plantations established by Dr. Fernow on the Cornell Forestry College Forest at Axton. Thereafter we were delighfully entertained at tea by Mr. Meigs at his summer home on Ampersand Lake.

On Friday morning, September 7, a group visited the grave of Clifford R. Pettis, near Paul Smith's. All were impressed with the appropriate simplicity of the boulder, the tablet, and their surroundings. After a floral tribute had been placed, Professor Hosmer summarized briefly Pettis' achievement as Superintendent of State Forests, bringing to all a realization of the high public service performed over a period of a quarter of a century by this man who "Built up and developed the New York State Forest Preserve for the permanent use and enjoyment of his fellow citizens."

Nelson Spaeth,
Secretary-Treasurer.

Washington Section Considers Taxation, Lightning and Flood Control

The monthly meeting of the Washington Section on November 22, 1928, opened with a paper by Fred Morrell, District Forester at Missoula, Montana, on economic phases of the cut-over land problem of northern Idaho. He drew attention to the great portion of timbered and non-producing cut-over land in Idaho which is at present subject to heavy taxation, not only by a state which is relatively poor, but by the timber protection associations. Conditions are becoming unbearable for the private timber owners. Making it worse is a state law permitting execution upon any and all property a timber owner may have to satisfy the tax assessments. In other words the owner cannot evade the tax bill levied on cut-over land by abandoning it to the state.

It was pointed out by E. A. Sherman, Associate Forester, U. S. Forest Service, that one of the large railroads which traverses the state proposes, in order to escape such liability, to form a separate corporation to which all timberland properties will be transferred. Taxes cannot be collected from a defunct corporation. Unless the state of Idaho alters its taxation laws it seems that the Federal Government is the only corporation which can handle cut-over land. It appears that the state of Idaho cannot very handily

raise the money with which to add more forest land to its present holdings.

Ward Shepard spoke of his recent inspection trips in northern Idaho and of the good efforts timber operators are making to comply with the state laws with respect to slash disposal, etc. It appears that in addition to the state taxes the timber owner is assessed from six cents per acre upward by the timber protection associations. The feasibility of a state bond issue with which to acquire cut-over land was discussed, but the consensus of opinion was that the state of Idaho is not able to meet a bond issue. It was suggested that legislation might be obtained whereby gifts of cut-over land could be made to the Federal Government.

E. A. Sherman brought to the attention of the Section reports submitted to the Congress by the Mississippi River Commission and the Chief of Engineers, U. S. Army, dealing with flood control of the Mississippi River. Special reference was made to the discussion in these regarding the part forestry played in flood control. This is very little in the eyes of the army engineers and members of the Mississippi River Commission who are supposed to have studied the subject. Mr. Sherman pointed out some gross errors in the Mississippi River Commission's report, and the inexperience and unfamiliarity of the personnel of the Commission with forest conditions or the possibilities of forestry as an aid to flood control. It appears also that the army engineers made gross errors in their calculations and statements with regard to forestry in a scheme of flood control. It is clear that the engineers of the army and of the Mississippi River Commission intend to continue to follow their own ideas in flood control, as has been done for the past half century without adequate results or plans to show for the large sums of money expended.

The Army and Mississippi River Commission's reports are published as Document No. 90 and Committee Document No. 1 respectively, 70th Congress, first session, House of Representatives.

Paul G. Redington, Chief of the Biological Survey, suggested that the Society of American Foresters take up the study of the whole question of Mississippi River flood control. The suggestion was favorably received.

Another subject upon which Mr. Sherman spoke was the increasing number of forest fires occurring in northern Idaho, particularly on the Kaniksu National Forest. It is known that years ago when all the country surrounding the Kaniksu was heavily timbered fires were much less frequent than at present. Severe electrical storms are now common. One storm has been known to set 200 fires on this forest in a short space of time. These conditions have set men to thinking as to the cause. While admitting that he had no figures of proof Mr. Sherman advanced the theory as well as a plausible argument that the increased number of fires is due to the climatic changes brought about by the large areas of barren and denuded land lying to the west and across Clarks Fork of the Columbia River, which areas were formerly heavily timbered. The dry, hot winds sweeping across those areas of barren rock and coming in contact with the cool air rising from the Kaniksu country produce sudden changes followed by electrical storms. This is something worthy of thought.

Axel H. Oxholm, of the Department of Commerce, briefly described his official tour of European forests during the past

summer. He stated that European manufacturers are utilizing small timber down to 4 inches in diameter by use of improved machinery and are making money, even though the labor costs at present are comparable to those in this country. Lumber cut by the improved machinery does not require resurfacing.

Mr. Oxholm arranged while in Europe for this Section an exchange of forestry films.

This Section plans to study in the future defensive and offensive measures against our oldest, most aggressive, and unconquered enemy, " forest fires."

MORGAN PRYSE,
Secretary.

SOUTHEASTERN SECTION HOLDS MIDNIGHT SESSION

Following a banquet at the Phœnix Hotel, Waycross, Ga., on September 21, 1928, the third meeting of the Southeastern Section of the Society was called to order at 10.30 P. M. by Chairman Lenthall Wyman, who informed the Section of the survey being made to determine the type and amount of equipment used and purchased by foresters. The purpose of this survey is to gain statistics to be used in an advertising campaign designed to bring together manufacturer and buyer of forestry equipment through the medium of advertising in the JOURNAL OF FORESTRY.

Dr. C. H. Herty suggested that foresters should make some sort of arrangement whereby they get systematized press service. As an example of getting a technical subject before the public he gave the manner in which the Chemical Society achieves greater publicity for chemistry. They have a salaried officer whose duty it is to meet and furnish press agents with articles and news relating to chemistry.

Following the business meeting two papers were given, one by L. E. Sawyer, of the Georgia Forestry School, on " Nursery," and another by B. M. Lufburrow, State Forester of Georgia, on " Forest Fire Fighting Technique."

Among the visitors present at the meeting were J. G. Peters, W. R. Mattoon, and H. N. Wheeler of Washington; Charles H. Herty, Chemical Advisor of the National Research Council, New York; S. H. Marsh of Virginia; and C. F. Evans of New Orleans. These men, as well as members of the Section, were in attendance at the Georgia Forestry Fair held at Waycross.

The Section now has twenty-six members and is making plans for its next annual meeting to be held early in 1929.

The meeting adjourned at 1.00 A. M.

V. L. HARPER,
Acting Secretary.

WASHINGTON SECTION URGES SOCIETY TO STUDY FORESTRY PROGRAM

At a meeting of the Washington Section of the Society of American Foresters held on December 20, it was

VOTED, that the Society of American Foresters be respectfully requested to appoint a Committee to study the present national forestry program and to recommend, at as early a date as possible, additional measures and objectives that in its opinion may be practicable for the more rapid development of forestry and the curbing of forest destruction; such study to include, if feasible, a thorough analysis, with competent legal advice, of public regulation of timber cutting, either through state or federal action or both, as one possible solution.

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The Executive Council consists of the above officers, the Editor-in-Chief of the Journal of 'orestry, and the following members:

	Term expires		Term expires
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		Member in charge of admissions	
ᴀLDO Leopold	Dec. 31, 1931		
. T. Munger	Dec. 31, 1930	E. H. Frothingham	Dec. 31, 1928

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Arthur Koehler, Chairman, Forest Products Laboratory, Madison, Wis.
R. P. A. Johnson, Secretary, Forest Products Laboratory, Madison, Wis.

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Art.—article; ed.—editorial; rev.—review; art. (rev.)—review of article or book by; n.—note; s. a.—society affairs. Authors are indicated by capitals.